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THE
NEW SCHOLASTICISM
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SUBSTANTIAL CHANGES IN ORGANIC MATTER

Out of the earth to rest and range
Perpetual in perpetual change,
The unknown passing through the strange.
—John Masefield, *The Passing Strange.*

1. Introduction.

WE ARE living in a dynamic universe. Most of the matter about us is in motion. This is true from the tiny electron which restlessly makes some seven billion (or so) revolutions in a millionth of a second in its tiny orbit around the hydrogen nucleus to the swift motion of the mighty extra-galactic nebulae, which move at a terrific rate of speed in the vast depths of inter-nebular space. Modern theory maintains that the sun is losing part of its mass and this at the rather astonishing rate of about 4,200,000 tons a second. Brighter stars are losing more, of course. To form the relatively small current of one ampere 6,280,000,000,000,000,000 electrons have to pass a point along a conducting wire in a single second.[1]

But changes that are more deep-seated in affecting the very natures of bodies also occur. An electron and a positron unite

[1] Keith Henny, *Principles of Radio* (1934), p. 11.

to form a photon of energy, with their electrical charges disappearing; a photon striking matter (under proper conditions) dies giving birth to a pair of electrical twins (an electron and a positron); somehow that "fundamental nuclear particle" can take on the neutron or the proton phase, or perhaps one is converted into the other; atomic nuclei can "emit" or "absorb" electrons and positrons which we have good reason to suspect do not exist there formally. The absolute fixity of the chemical elements has disappeared; the fixity of matter itself has vanished; light (more accurately, radiation) itself may be converted into matter; the mesotron makes its flash in the world and disintegrates in a very small fraction of a second—out of the debris rises an electron and a neutrino.

In atomic nuclei we have only relative stability. In regions of rather high thermal excitation, we find the chemical metastable compounds; then in regions of greater coolness we have chemical compounds of greater stability. On the other extreme, under favorable conditions, we may find "degenerate" matter —where matter has lost all its "special" properties.

Would not such a universe delight the heart of Heraclites! At length even the spectre of Parmenides has been banished from the world of matter! What then endows the world of matter with its quasi-stability, which almost everyone takes for granted.

The scholastic theory of act and potency clarifies and renders intelligible in our actually existing world the static notions of substance and accident. When this is applied to the problem of transformation of bodies, we come across the scholastic theory of matter and form. In a previous cursory sketch [2] on the nature and structure of inorganic matter we have outlined a few points from the *static* point of view. Let us now add a few random notes on the *dynamic* side.

[2] *New Scholasticism*, 14, 33, 1940.

2. The Scientific Point of View.

In 1931, G. Gamow wrote a book called "The Constitution of Atomic Nuclei and Radioactivity." In 1936, he wrote a larger book called "The Structure of Atomic Nuclei and Nuclear Transformations." He mentions in the latter book (page v) that in writing the first edition he felt unhappy because there were not enough experimental facts and theoretical calculations, but now (in 1936) he felt that there were perhaps too many. What his sentiments are in 1944 I do not know.

We shall consider the scientific evidence in three parts—concerning individual fundamental particles, atomic nuclei, and chemical changes respectively.

A. *Individual Fundamental Particles of Matter.*

The Electron:—The electron occupies an exceedingly important place in the study of matter since it is normally the occupant of the peripheral regions of the atom.

The size of an electron has never been measured directly.[3] A crude estimate of its size has been previously given. We might add here that usually its size is not considered a strict constant, as the electron probably shrinks a bit when its speed is increased so that when it is moving at about the speed of 150,000 miles a second (about 80% of the speed of light) its size is roughly only ⅗ of its slow motion size.

The mass of the electron also seems to be dependent on its velocity. For instance, when an electron moves with about $\frac{1}{10}$ the speed of light, its mass seems to increase about .5%. However, when its velocity approaches about $99\frac{8}{10}\%$ of that of light its mass is about 15.8 times as great as its "rest" mass.[4] It is also possible that this may be due to a "slippage" of the field.

[3] Caution is very necessary in accepting any of these estimates. Cf. K. T. Compton, *Nature*, 139, 234, 1937.

[4] Hevesy and Paneth, *Manual of Radioactivity* (1938), p. 36.

For a long time the electron was thought to be the sole possessor of the negative electrical charge. In fact, some thought it *was* the negative of electrical charge, etc. However, with the discovery of the negative mesotron, this view collapsed.

Before the discovery of the neutron, the electron was assigned a formal existence in atomic nuclei. The reason was simply this: The existence of the proton was known, and there was no other way of figuring out just how to balance off the excess positive charge. For instance, uranium may have an atomic weight of 238, but the excess positive charge is only 92. Of course, it was an unanswered question as to just how to squeeze the relatively "bulky" electron down to nuclear dimensions, and how to explain the electrical neutralization of their charges and the resulting dissipation of energy. In fact many thought that this might be a rather favorable explanation for the source of stellar energy.

But today the electron is not considered to have a formal existence in atomic nuclei for a number of reasons.[5] The neutron and the proton are its sole occupants. Perhaps there is an electron-position atmosphere surrounding the neutrons and protons which may have melted away to a fundamental nuclear particle—and perhaps there is not.

The old difficulty of a fundamental nuclear particle still remains. Are the proton and the neutron both independent particles capable of transforming into each other under certain conditions; or is the proton composed of a neutron and a positron or is the neutron composed of an electron and proton; or are both simply modifications of a "fundamental nuclear particle." H. J. Bhabha suggests that perhaps there are protons with double charges. He thinks "that the heavy particles could exist in states of all integral charge, positive and negative with

[5] Cf. G. Gamow, *Structure of Atomic Nuclei and Nuclear Transformations* (1937), and H. A. Bethe and R. F. Bacher, *Reviews of Modern Physics*, 8, 184, 196, 1936.

different rest energies, of which only the two of lowest energy (rest mass) namely, the proton and neutron, appear normally in nature."[6] The name "nucleon" was once suggested for heavy nuclear constituents, but it is not very popular."[7]

The real difficulty comes up in this way. We know that in certain transmutations electrons and even positrons are emitted from atomic nuclei. Now how can they be emitted if they are not there to begin with? We can draw on the analogy of orbital electrons emitting photons, but they are without an electrical charge—at least externally they are electrically neutral. It is easier to conceive of positions being emitted from the nucleus than electrons. And yet electrons are emitted in natural radioactivity while positrons are not. Both are emitted in artificial radioactivity.

There is another problem. Why do not electrons rush into the nucleus and collide with the protons (which attract them) and result in the production of photons? Sometimes they do, although it does not seem to be simply a question of electrostatic attraction. But these cases are not frequent. Usually, they can keep their distance because of their orbital revolutions. Perhaps there is also a repulsive force between protons and electrons at small distances.[8]

Some further questions regarding the interaction of electrons and other particles will be treated when we consider the other particles. One question remains for this section: Why has the electron a "relatively" stable existence, compared to the positron and mesotrons? We can answer this question only by asking another. Why is the positive electrical charge (due to protons) found in atomic nuclei. (That is, at least an *excess* positive charge.) If atomic nuclei were made of neutrons and negative protons, then positrons and electrons would probably

[6] *Phys. Rev.* 59, 100, 1941. [7] *Phys. Rev.* 59, 323, 1941.

[8] Cf. for instance, *Physical Review*, 57, 458, 1940; 56, 384, 1939, and *Proc. Royal Society*, 171, 269, 1939.

change places in the peripheral regions of atoms. The positron would then become a comparatively stable particle and the electron would decrease its life expectancy by quite a large factor. Perhaps this reversal may take place in "contraterrene" matter.

Many problems concerning the electron have not been mentioned, e. g., just how does it emit and absorb photons. Perhaps, as some have suggested, the electron has an internal structure.[9]

The Positron:—The positron was discovered in the observation of cosmic ray phenomena. It is not emitted in natural radioactive processes, but is found in the different products of artificial radioactivity. Positrons do not seem to have much of a permanent existence. Their presence is not demanded in the extra-nuclear regions of the atom, except perhaps in contraterrene matter—where nuclei would be consisted of neutrons and negative protons. If a positron collides with an electron at rest, the result is two radiation quanta, each of 500,000 electron volts.[10] These are usually emitted in opposite directions to conserve momentum. At times, however, a positron combines with an electron in such a way that the so-called "energy of annihilation" is emitted as a single quantum of energy of a million electron volts. Therefore, the incidence of positrons on matter usually results in the emission of high energy radiation, which is independent of the absorbing element. Positrons may also be released by the action of electrons when their energy exceeds a million electron volts.

A photon (or quantum of radiation) of energy greater than a million electron volts is able to disappear under certain conditions and give rise to an electron and a positron. Any energy the parent photon possesses which is above a million electron

[9] *Physical Review*, 56, 452, 1939.

[10] An "electron volt" is the kinetic energy acquired by an electron in traversing a field with a potential difference of one volt. It is usually abbreviated into "ev." One million electron volts is designated by 1 mev.

volts appears as kinetic energy of the electron-position pair, in accordance with the Conservation of Energy. This process is sometimes referred to as the "Materialization of Light," or simply as a "Materialization" process.[11]

The Mesotron:—The mesotrons and neutretto are very difficult particles to discuss because of the complicated and seemingly contradictory evidence available. Then too, different authors interpret the evidence in many different ways, and by the time some kind of uniformity of opinion is secured, new evidence again reopens the whole question.

Mesotrons have a very short life as independent particles. They seem to be knocked loose from atoms in some sort of way by cosmic ray primaries. Then, after their short life of a very small fraction of a second, they seem to decompose into an electron and neutrino or a positron and a neutrino, depending on whether the mesotron in question had a negative or a positive charge. Very much less is known about neutrettos, as they are electrically neutral particles and therefore will not leave tracks in the so-called "cloud-chambers." Pictures of the actual disintegration of mesotrons are very difficult to obtain but E. J. Williams and G. R. Evans[12] claim to have photographed the process. Ralph P. Shutt, S. DeBenedetti, and T. H. Johnson have also recently photographed the process.[13]

Paul Weisz writes concerning "The Rest Mass of the Mesotron": "It must be admitted that a few cloud-chamber photographs of tracks of slowest observable mesotrons in a strong magnetic field constitute the whole basis of our present knowledge of the rest mass of the mesotron. These records have yielded estimates of the rest mass of from about 100 times[14]

[11] A. E. Haas and I. M. Freeman, *Elementary Survey of Physics* (1938), p. 154, and R. A. Millikan, *Cosmic Rays* (1939), p. 32.

[12] Nature, 145, 818, 1940 (*Phys. Rev.* 58, 1018, 1940 also gives E. J. Williams and G. E. Roberts: *Nature*, 145, 102, 1940—the photograph of mesotron disintegration).

[13] *Phys. Rev.* 62, 552, 1942.

[14] *Phys. Rev.* 59, 845, 1941.

to as high as 540 times [15] the rest mass of the electron, values from 150 to 200 times the rest mass of the electron having been observed most frequently. Thus, one may, at present, merely state that a value of, say 180 m_e is *most probable*, and even here we shall allow for an error of say 20 m_e." [16]

Nielson and Powell have also published some measures for the rest mass of the mesotron. Four rather reliable measurements gave from 145 to 230 times m_e.[17] There appears to be no conclusive evidence at the moment concerning the "uniqueness" of the mesotron's mass.

Mesotrons have been invoked to develop a theory of nuclear forces. These theories have many variations, but in general they attempt to explain the specific nuclear (attractice) force by the emission and absorption of mesotrons and neutrettoes by protons and neutrons. Very frequently this is referred to as the "Meson Theory of Nuclear Forces." [18]

It might be well to bring the data for the "neutrino" up-to-date also. It is rather involved so it will not be presented here.[19]

Cosmic Rays:—This section is inserted to assist in safeguarding the material object of Cosmology. Energy is apparently produced in stars by ordinary nuclear transitions involving the conversion of "rest" mass into radiant energy. In cosmic ray phenomena, we deal with far higher energies. The source of cosmic ray phenomena apparently is not in the stars or nebulate, but in the regions in between. The radiation appar-

[15] P. Auger, *Comptes rendus*, 206, 346, 1938.

[16] E. J. Williams and E. Pickup; *Nature*, 141, 684, 1938.

[17] *Phys. Rev.* 63, 385, 1943.

[18] Some prefer the name "meson" to mesotron. See, for instance, *Phys. Rev.* 57, 262, 1940. However, the name "mesotron" is sticking rather well. The best recent estimates for the proper life-time of the mesotron are from 1 to 5 X 10^{-6} second, which is from one to five one millionths of a second. (Cf. *Phys. Rev.* 58, 576, 1940; 58, 766, 1940; 58, 191, 1940; 59, 845, 1941; 61, 675, 1942).

[19] Cf. e. g. "Experimental Evidence for the Existence of a Neutrino." (*Phys. Rev.* 61, 692, 1942.)

ently reaches the earth equally from all directions. We know from the evidence of "interstellar" lines in stellar spectra, light absorption in space, etc., that there is a good bit of matter in so-called "interstellar" space. However, it is not as yet clear just where cosmic ray primaries obtain their high energies, why only certain particles acquire these energies, etc.

Primaries:—The energy is transmitted from interstellar space to the outer limits of the earth's atmosphere by certain "carriers." This is called the "primary radiation," and in order to measure its energy and distribution, observations of the incident energy of these "primaries" must be conducted as close to the top of the earth's atmosphere as possible. Naturally, this is very difficult, but it has been accomplished at altitudes where about 98% of the earth's atmosphere was below the recording instruments. What are these "primaries." One of the "opinions" at the present time is that there is only one type of primary radiation, a charged particle radiation. These comprise particles of heavy mass—many thought protons.[20] Millikan, Neher, and Pickering held that "not less than, and probably much more than, 60% of the total incoming cosmic ray energy (primary radiation) is carried by these charged particles"[21] but they point out certain difficulties. Later these same authors held that about 60% of the total incoming cosmic-ray energy is field sensitive and that these "incoming cosmic-ray charged particles must be electrons rather than protons or any other particles essentially more massive than electrons."[22] It is probably well to suspend final judgment on this very difficult point.

The Earth's Magnetic Field:—The earth is a magnet. We cannot at the moment go very deeply into the question, and so it must suffice to point out that "an analysis of the geographic variations of the earth's magnetism shows that it may be at-

[20] *Phys. Rev.* 59, 770, 1941; 59, 615, 1941; 59, 763, 1941; 63, 210, 1943.
[21] *Phys. Rev.* 61, 398-399, 1942. [22] *Phys. Rev.* 63, 245, 1943.

tributed to a strong central dipole making an angle of 11½° with the axis of rotation of the earth, and to fourteen subsidiary dipoles located on the surface of the core, each only about 1/100 as strong as the central dipole." [23] The earth's magnetic field exerts a "blocking effect" on vertical incoming charged particle primaries, which is greatest at the magnetic equator and least at the magnetic poles. What makes the problem more involved is that there is also a "longitude" effect, namely, it will vary in the same magnetic latitude. Thus a charged particle has to have an energy of at least 13 Bev (billion electron volts) to get through the "blocking effect" of the earth's magnetic equator in Peru, and a still greater value of 17 Bev on the magnetic equator in India. The charged particles could come in a number of ways:

(1) Non-discrete energies—varying uniformly over the energy spectrum.

(2) Discrete energies:

(a) Single value or one small "band."

(b) Several "bands."

Now 2b fits in best with experiments. When these bands of charged primaries attempt to enter the earth's magnetic field, different blocking effects at different magnetic latitudes plus the different incoming energies of the charged primaries themselves give rise to a plateau effect when the two are plotted against each other. A great deal of information is assembled in Table 1. Column one is the name of the element; column two represents the relative abundance of the different elements in interstellar space; in column three we find the energy transmitted to the carriers (charged primaries) by the conversion of the "rest" mass of the element named in column one—always safe guarding the principle of conservation of momentum. The fourth column represents the magnetic latitude down to which (from the magnetic pole) the primaries have sufficient energy

[23] *Phys. Rev.* 59, 182, 1941.

for vertical penetration. In the fifth column are five localities found at five corresponding magnetic latitudes. Other magnetic latitudes may be found roughly by using a piece of string and measuring off the desired number of degrees of geographic latitude or co-latitude (latitude subtracted from 90°) depending on our method of measurement, on a global map. Then keeping this length, place one end of the string not on the earth's geographical poles, but on either the earth's north magnetic pole (near Cape Adelaide Regina on the Boothia Peninsula in the District of Franklin in the Northwest Territories of Canada—roughly at 70° N., 96½° W. in geographical coordinates) or on the south magnetic pole (on South Victoria Land, Antarctica, about 72° S., 155° E. in geographical coordinates). The other end of the string will then generate a small circle (or a great circle at the magnetic equator) on the globe which will be the locus of that particular magnetic latitude, either north or south, depending from which pole we measure. Needless to say the measurements will be very rough.

TABLE 1.

ABUNDANCE OF ELEMENTS IN INTERSTELLAR SPACE.
ENERGY OF PRIMARIES ARISING FROM THEIR TRANSMUTATION ENERGIES.
LIMITING MAGNETIC LATITUDE OF THEIR VERTICAL PENETRATION.

Element	Approximate abundance. Ratios.	Energy in Bev	Limiting Magnetic latitude of their vertical penetration.		Some known locality
Hydrogen	100				
Helium	10	1.9	57°		Bismark, N. D.
Carbon	1	5.6	42°		San Antonio, Tex.
Nitrogen	1	6.6	34°		Victoria, Mexico
Oxygen	1	7.5	30°		(32.8 N. Magnetic)
Silicon	1	13.2	—	0° (Peru) = 13 Bev	(Blocking effect)
				0° (India) = 17 Bev	(" ")
B, Ne, S.	1/10				
Li, Be, Al, P, V,	1/50				
Na, Mg, Cl, Fe.	1/50				
A, Ca, Ti, Cr, Mn	1/100				
K, Sc	1/500				
Fl	1/1000				

Remarks on table 1: Keeping in mind the principle of the conservation of momentum two particles of electron mass from hydrogen atom with 500,000 ev apiece could scarcely get through sun's magnetic field to the earth, and if they did even this, could scarcely get through earth's magnetic field (even at the poles). From the hydrogen molecule's rest mass, we could get two oppositely directed electrons of 0.938 Bev.

Perhaps phosphorus, sulphur and aluminum may be added to silicon, calling the whole thing (in the above table) the "silicon band" for the present.

The silicon band (energy 13.2 Bev) can get through on the magnetic equator in Peru (where the blocking effect is equivalent to about 13 Bev) but not in India (Where the blocking effect amounts to 17 Bev). Further experiments are bearing out the data on helium, and oxygen.[24]

Secondaries:—Division of cosmic rays:

By reason of origin: {Primaries—Carriers of incoming energy. Secondaries—Formed in earth's atmosphere either by primaries or other secondaries.

By reason of energy: {Hard—Greater energy (often also called "penetrating) Soft—Less energy.

When primaries hit the earth's atmosphere, they are quickly absorbed, not $\frac{1}{500}$ of their energy being able to get down to sea level.[25] The exact process of the formation is not known,[26] but we do know that mesotrons are formed from these primaries. These mesotrons so formed seem to have a definite though a very short life time, estimated rather consistently at about 2.8×10^{-6} second. (28/10,000,000 of a second or 0.0000028 second.)[27] Therefore, if they wish to go anywhere they have to do so in a hurry for their life is short and their death is sure. Consequently, faster ones go a good distance, whereas the slower ones

[24] For helium: *Phys. Rev.* 65, 152, 1944.
For oxygen: *Phys. Rev.* 63, 140, 1943.

[25] *Phys. Rev.* 61, 399, 1942.

[26] *Phys. Rev.* 61, 399, 1942.

[27] *Phys. Rev.* 58, 766, 1940 (Neher and Stever); 61, 675, 1942 (Rossi, Greisen, Stearns, Froman, and Koontz). . . . The value of 5×10^{-7} second has also been given. (*Phys. Rev.* 59, 845, 1941.)

do not get very far. All " secondaries " are divided into " hard " (or " penetrating ") and " soft."

Those mesotrons which are born approximately at rest will have such short lives that they will disintegrate before they have travelled more than 300 meters or 330 yards. They will, in fact, disintegrate in the stratosphere, and in so disintegrating will give rise to electrons, which, on account of the disintegration occuring from mesotrons at rest, will emerge on the average equally in all directions. . . . The mesotrons formed with higher energy will disintegrate at lower altitudes, because of their longer lives, and because they disintegrate at high energy, will give rise to electrons which possess on the average a forward component at these lower altitudes.[28]

It is now generally believed that the soft component of cosmic rays at sea level consists of electrons, and that the bulk of these electrons arise from mesons, or the penetrating component of cosmic rays. Electrons arise from mesons (or mesotrons) by three different processes. (1) Mesons create collision electrons (sometimes also called " knock-ons " or " delta-rays ") by elastic Coulomb encounters with atomic electrons. (2) Mesons which pass very close to atomic nuclei radiate quarta. The quanta can give rise to electrons by materialization. (3) It is believed that the radioactive decay of the meson liberates an electron and a neutrino. Energetic electrons arising from all three of these processes give rise to cascade progeny. These electrons make up the soft component, which is in equilibrium with the meson component at sea level.[29]

Another thing which this section on cosmic rays shows is that all the interactions among the different " elementary " particles is not just something " speculative," but is a constant occurance and that on a large scale. In many discussions we are inclined to restrict ourselves to superficial terrestrial phenomena. This will, perhaps, make them more cosmic.

B. *Atomic Nuclei.*

Nuclear Transmutations:—The nuclei of atoms are composed of protons and neutrons. The number of protons in the nucleus

[28] *Phys. Rev.* 59, 770, 1941. [29] *Phys. Rev.* 62, 204, 1942.

decides fundamentally (from the scientific point of view) the nature of the chemical element. It was noticed towards the close of the nineteenth century and during the first years of the twentieth century that the element radium behaved in a way that could only be interpreted as changes in its nuclear constitution, and that in a way which naturally gave rise to new elements. We know today that all the elements heavier than mercury (i. e. thallium, lead, bismuth, polonium, radon, radium, actinium, thorium, protoactinium, and uranium) have isotopes (samples of the same element with a different number of neutrons in the nucleus) that are naturally radioactive.

Scientific investigators immediately started trying to imitate nature in bringing about the transmutation of the elements. Their first success came in 1919. At first they had to use nature's sources to obtain particles with high energies. But gradually instruments came into being which could endow individual particles with the same tremendous energies as were found in natural nuclear disintegrations. Man has been rather successful up and down the atomic table and so the absolute immutability of the elements has become a discarded concept.

"At the present time every element, without exception, has thus been disintegrated, a new element being in general produced. . . . There are 386 known stable forms of isotopes. There are 335 artificially produced radioactive substances." [30] There are tables giving the relative abundance of these different isotopes of the elements.[31]

Artificial transmutation of the elements takes place, in general, when two nuclei meet (or a nucleus, and a neutron, or another elementary particle, or sometimes high energy photons) and enter into a reaction with each other. They usually meet by projecting one against the other. So as a rule, we then speak of a "projectile" and a "target." Now "hits" by the pro-

[30] *Science*, 91, 327, 1940.
[31] *Reviews of Modern Physics*, 12, 30, 1940.

jectiles are usually rare. The projectiles usually used (in artificial transmutation) are either protons (ordinary hydrogen nuclei), deuterons (hydrogen nuclei composed of one proton and one neutron), helium nuclei, or neutrons.

Let us take an atomic nucleus. It is composed of protons and neutrons in a somewhat stable state. The specific nuclear force is capable of preventing the different particles from leaving the nucleus despite the energy which they possess. However, this retaining force is not unlimited in value. If some process takes place by which the different particles obtain more energy so that they now have sufficient energy to overcome the forces tending to keep them in that nucleus, several things may happen. We must always remember that the total positive charge of the atomic nucleus determines fundamentally (from the scientific point of view) the nature of the element, because sometimes the nucleus gets rid of the extra energy without disturbing the net positive charge of the atomic nucleus, and then no transmutation of the elements takes place. However if the net positive charge of the nucleus is changed, we have one or more new elements.

There are a few terms which should be considered here before taking up the changes in detail. Atomic nuclei which have the same total number of neutrons and protons, but different numbers of protons (and therefore, also neutrons) are said to be "isobars" (same atomic weight). Thus the calcium atom with 20 protons and 20 neutrons and the argon atom with 18 protons and 22 neutrons are isobars. Atomic nuclei having the same number of protons, but different numbers of neutrons are said to be "isotopes" (same kind or type, since they are types of the same element). Thus the nitrogen atoms has two isotypes. In an ordinary sample of the element 99.62% of the nuclei will have 7 protons and 7 neutrons, while the remaining .38% will have 7 protons and 8 neutrons.

A kind of shorthand is necessary to represent nuclear changes concisely. Two systems are in common use. Both use the chemi-

cal symbol of the element to represent the nucleus of the element; both use a preceding subscript to denote the atomic number (number of protons in the nucleus); both agree in using superscripts to denote the atomic weight (combined number of neutrons and protons). They differ in this; one system uses a *preceding* superscript for the atomic weight, the other one that *follows* the symbol of the element. Let us take an example.

First system:

$$_3Li^7 + {}_1H^1 = {}_4Be^8 = 2\,{}_2He^4$$

Second system:

$$_3{}^7Li + {}_1{}^1H = {}_4{}^8Be = 2\,{}_2{}^4He$$

In either system we read this as follows: Lithium of atomic number 3 and atomic weight 7, when suitably bombarded with simple hydrogen nuclei (protons) will give us beryllium of atomic number 4 and atomic weight 8. This, in turn, will decay [32] into two helium atoms of atomic number 2 and atomic weight 4.

In the isotopes of hydrogen, the type having one proton and one neutron is called ' deuterium." A single atom of it is called the " deuteron " (the symbol is " D "). Thus the so-called " heavy " water is deuterium oxide and the chemical formula is D_20. The isotope of hydrogen having one proton and two neutrons is called triterium. A single atom of it is called the " triton." In a natural sample of hydrogen, the isotype having only one proton and no neutrons constitutes 99.98% of the sample.

The Alpha-Particle:—The α-particle is composed of two protons and two neutrons in a very close and stable union, i. e., it would take a good bit of energy to overcome their " binding " energy. At first it was taken for granted that these α-particles

[32] For sake of accuracy, only 50% of the beryllium nuclei will decay into two helium nuclei.

were constituents of the heavier atomic nuclei, so that an atomic nucleus was made up of so many α-particles plus a few extra protons and perhaps neutrons to round out the requisite atomic number. Then a change in view took place as typified by the following: "Alpha particles lost all claim to consideration as permanent units in nuclear structure when a general theory of nuclear constitution was developed."[33] But later evidence (especially the explanation of the nuclear electrical quadrupole moment)[34] has reopened the whole question. The history of the question with views pro and con is well given by D. R. Inglis.[35] A deuteron (union of one proton and one neutron) group model for the alpha-particle is considered in addition to the simple alpha-group by others.[36] Others think there is definite evidence that protons in the nucleus are grouped in pairs whether neutrons are associated with them or not.[37] This latter idea would then lead to the conclusion that in general, elements with even atomic number are more stable than the odd-numbered elements, and should therefore, be more abundant. In 1917, Harkins [38] pointed out that elements of even atomic number are predominantly abundant both in the earth's crust and in meteors. This rule has been confirmed by x-ray analysis of terrestrial and stellar matter [39] and is splendidly illustrated by the relative abundances of the rare earths. A recent estimate states that elements with even atomic number constitute 87 percent of the earth's crust.[40]

Ordinary Nuclear Changes:—The greatest number of nuclear changes are caused by getting one or more protons, neutrons, or both to stick in the "target" nucleus, or by getting some of

[33] *Phys. Rev.* 59, 27, 1941.
[34] *Phys. Rev.* 62, 197, 1942.
[35] *Phys. Rev.* 60, 837, 1941.
[36] *Phys. Rev.* 62, 109, 1942.
[37] *Phys. Rev.* 62, 27, 1942.
[38] *Jour. Am. Chem. Soc.* 39, 856, 1917.
[39] Georg von Hevesy, *Chemical Analysis by X-rays and Its Application* (McGraw-Hill Book Co., 1932).
[40] Franco Rasetti, *Elements of Nuclear Physics* (Prentice-Hall Inc., 1936), p. 160.

them removed from the original nucleus. Then again, by suitable bombardment the target nucleus may get into an " excited " (i. e. with excess energy) state, and then get rid of some of this extra energy by the emission of an electron, position, or other particles. Neutrons are also absorbed and emitted and so is a good bit of energy in the form of photons, but since they possess no external electrical charge, they do not change the type of nucleus, and so we will not consider these phenomena very much. Neutrons and positrons are not emitted in natural radioactive processes, but they are in artificial radioactivity or nuclear transmutations. Electrons and helium nuclei are emitted even in natural radioactivity.[41] A lot of examples could be given but instead five different ways of preparing radioaluminum (with 13 protons and 15 neutrons) will be given.[42]

$$_{13}Al^{27} + {}_{0}n^{1} = {}_{13}Al^{28}$$
$$_{15}P^{31} + {}_{0}n^{1} = {}_{13}Al^{28} + {}_{2}He^{4}$$
$$_{13}Al^{27} + {}_{1}D^{2} = {}_{13}Al^{28} + {}_{1}H^{1}$$
$$_{14}Si^{28} + {}_{0}n^{1} = {}_{13}Al^{28} + {}_{1}H^{1}$$
$$_{12}Mg^{25} + {}_{2}He^{4} = {}_{13}Al^{28} + {}_{1}H^{1}$$

Nuclear Isomerism:[43]—Nuclear isomerism is the phenomenon in which different atomic nuclei of the same isotope are in different energy states and will emit or absorb an uncharged

[41] " The artificially radioactive elements have mass numbers which do not correspond to any known stable variety of atom. They are usually either less than the smallest or greater than the largest mass number otherwise found among the isotopes of the element. In the first case, the radioactive element emits positrons, in the second case, electrons." (A. E. Haas and I. M. Freeman, *Elementary Survey of Physics* (1938), p. 154.

[42] G. Hevesy and F. A. Paneth, *A Manual of Radioactivity* (1938), p. 123.

[43] There is also the possibility of nuclear isomerism if the negative proton actually exists. This would then occur, if, for instance, a positive and a negative proton replaced a pair of neutrons. Such isomeric nuclei would then differ in their binding energy, sprin, and if unstable, probably also in their mode of disintegration. However, the existence of the negative proton is not at all proved. If it exists in the so-called " contra-terrene."

particle, radiation, or a charged[44] particle differently and usually in a different interval of time; or they may emit the same particles at different intervals.

Let us take the case of a certain isotype of silver ($_{47}Ag^{106}$) formed from palladium.[45] This isotype of silver is not stable but has two forms of nuclear emission. Some of the nuclei of this isotope may then emit positrons (and that quite quickly) and we again obtain palladium:

$$_{47}Ag^{106} = {}_{46}Pd^{106} + {}_{1}\delta^{0} \text{ (Half-life}^{46} = 20.5 \text{ minutes)}$$

Other nuclei of this same isotype of silver may emit electrons (somewhat more slowly) and we obtain cadmium:

$$_{47}Ag^{106} = {}_{48}Cd^{106} + {}_{1}e^{0} \text{ (Half-life} = 8.2 \text{ days)}$$

These two types of nuclei of the silver isotype are then called "isomeric pairs"; the electrons or positrons emitted are usually called "internal conversion" electrons or positrons; the actual emission or absorption is called an "isomeric transition"; the whole process is called "nuclear isomerism."[47]

"For the study of artificial radioactivities it is a fortunate experimental fact that two nuclear isomers can be separated chemically.[48] However, since no transmutation of elements is involved in the isomeric transition, the mechanism of the sepa-

[44] Of either sign, but with a mass less than that of a neutron or proton.

[45] It is formed from palladium in the following way:

$$_{46}Pd^{105} + {}_{1}D^{2} = {}_{47}Ag^{106} + {}_{0}n^{1}$$

[46] "Half-life" or "half-period" is the time it takes for one half of a given sample to disintegrate.

[47] The illustration given above is an example of one type of transition. By carefully examining the definition one can see that several different kinds are possible, but it would take too long to give examples of all kinds. The above definition is the author's own and does not pretend to be complete or final. Mention of the so-called "upper" and "ground" states is avoided, in order to steer clear of the contentious terminology of "compound" and "residual" nuclei, and also not to drag in the further subjects of nuclear energy states, packing fractions, etc.

[48] E. Segre, R. S. Halford, and G. T. Seaborg, *Phys. Rev.* 55, 322, 1939.

ration is not at once clear. Evidently molecular dissociation must accompany the transition; that is, the emission of a gamma-ray must in some way rupture chemical bonds. It has the gamma-ray supplies such a mechanism . . . Usually this is not the case . . . The nuclear recoil is very small or small compared to chemical binding and cannot be responsible for an appreciable separation. When an electron is emitted, an atom acquires a charge of e and its chemical properties are temporarily altered. The outer electrons, responsible for molecular bindings, move in a new field to which the wave functions are readjusted in times short compared to molecular periods. The molecular states will tend to become more and more repulsive since the excess charge will tend to distribute equally over the molecule. If, as a result, the molecule becomes unstable by several volts there will be ample time for dissociation before the excited atom returns to the ground state by electron capture." [49]

Using " fast " neutrons (of energies amounting to a million or even millions of electron volts) fission can be produced in a different isotope of uranium (U^{238}), and also in thorium and protoactinium.[51]

This is what seems to happen with thermal neutrons and U^{235}.[52] A slow moving neutron moves into the U^{235} nucleus, and this nucleus then almost promptly bursts into two nearly (but not quite) equal fragments. One uranium nucleus, on being entered by a neutron, may burst into barium ($_{56}Ba$) and krypton ($_{36}Kr$), another into xenon ($_{56}Xe$) and strontium ($_{38}Sr$), and another perhaps into caesium ($_{55}Cs$) and rubidium ($_{37}Rb$).

[49] E. P. Cooper, *Phys. Rev.* 61, 1, 1942.

[51] *Phys. Rev.* 56, 382, 1065, 1939.

[52] The true explanation of nuclear fission came about four years after the phenomenon was first observed. Photo-fission of Uranium and Thorium has now been observed. γ-rays from flourine were used. (*Phys. Rev.* 59, 57, 1941.) γ-rays are a type of electromagnetic radiation. Their wavelength is shorter than x-rays and therefore their energy is also much greater.

This entire positive charge of the original uranium nucleus is in the two initial fragments. Besides these two main initial fragments several free neutrons are liberated.[53] Whatever the initial fragment-pairs may be, one at least and probably both are the parents of a long chain of radioactive bodies.

One of the fragment-pairs belong to the light-weight group (from $_{35}$Br to $_{43}$Ma), the other belongs to the heavy-weight group (from $_{51}$Sb to $_{57}$La).[54]

The two original fragments may be barium and krypton. The barium nucleus may try to stabilize itself by emitting an electron, and then it becomes lanthalum. This may again emit an electron from its nucleus and we have cerium. The krypton usually also disintegrates in a somewhat similar way, successively becoming rubidium, strontium, and perhaps yttrium and zirconium.

The Transuranic Elements:—Since these elements (those of greater atomic number than 92) have a somewhat "long" and colorful history, a few words of explanation might be in order. E. Fermi (in May and June 1934) announced[55] the discovery of elements of greater atomic number than uranium. A number of other investigators also thought that they had evidence for these so-called "transuranic" elements.

[53] The energy released in nuclear fission is tremendous. TNT is less productive of energy than the union of hydrogen and oxygen to form water, and the latter yields only about two or three electron volts of energy per molecule. In nuclear fission this is stepped up to 175,000,000 electron volts. 200,000,000 electron volts are equal to about 3/10,000 erg. It would take about 25,000,000,000 fissions per second to produce one horsepower. But remember that in a cubic inch of air (which is not a very dense gas) there are about 440,000,000,000,000,000,000 molecules. "Dr. Nier estimates that one pound of U^{235} would generate as much force as the combustion of 2,000,000 pounds of coal, or that its detonating energy would be equivalent to that of 20,000,000 pounds of high explosives." (*Scientific American*, 163, 16, 1940.)

[54] *Phys. Rev.* 57, 664, 1940.

[55] E. Fermi, *Nature*, 133, 757, 1934 (May 19); 133, 863, 1934 (June 9); 133, 898, 1934 (June 16).

The resultant products of Fermi's experiments (which was really uranium fission) were always minute in quantity, and so X-ray spectra could not easily be obtained. There was some uncertainty about the chemical identification due to the reappearance of properties in groups in the periodic table. So at first they were given the cautious and conservative interpretation of being new elements—heavier than uranium. Then early in 1939, several investigators [56] made the surprising discovery that at least one of the products from uranium disintegration was an isotope of the element barium (atomic number is 56). Now this a long way from the atomic number of uranium, and so this and subsequent observations proved that the so-called "new" elements were not new ones at all but old ones, and that here was a case that was entirely new—where the parent nucleus did not change a *few* points up or down the scale of the elements, but the nucleus was ruptured, practically into two fairly equal parts. And so they arrived at the correct interpretation of "nuclear fission." This was the status of the problem when my last article was published and so the status of the transuranic elements was at that time again in doubt, although element 93 was not entirely disposed of.

However, Edwin McMillan and Philip Hauge Abelson [57] now report the existence of elements 93 and 94. Let us look at the subject as it stands today. The most common isotope of uranium is U^{238} (92 protons and 146 neutrons). U^{238} constitutes 99.2[8]% of a normal sample; [58] U^{235} about 0.71%; and U^{234} is present in traces only. (.006%) Bohr and Wheeler [59] state that the relative abundance (in a normal sample) of U^{235} and U^{234} to U^{238} are as 1/139 and 1/17,000 are to 1.

[56] O. Hahn and F. Strassmann, *Naturwissenschaft*, 27, 11, 1939: L. Meitner and O. Frisch, *Nature*, 143, 239, 1939.

[57] *Phys. Rev.* 57, 1185, 1940. Cf. also *Science*, 91, 8 (suppl.), 1940; and *Science News Letter*, 37, 387, 1940. *Phys. Rev.* 58, 178, 1940; 58, 181, 1940.

[58] *Reviews of Modern Physics*, 12, 33, 1940.

[59] *Phys. Rev.* 56, 439, 1939.

U^{238} undergoes fission only when fast neutrons are used. By using slow (thermal) neutrons, uranium fission is obtained best of all from U^{235}, then from U^{234}, and finally to a very small extent from U^{238}. This was proved when separated samples of the various isotopes were used. Nevertheless, even in ordinary uranium, in which U^{235} is only 1/139 as abundant as U^{238}, U^{235} still accounts for 75% of the fission when thermal neutrons are used as the projectiles.[60]

When an ordinary sample of uranium is bombarded with slow neutrons, U^{235} and to an extent U^{234} undergo fission of their nuclei. But what happens to U^{238}. It picks up a neutron, and then emits an electron, raising its atomic weight by one, and the net positive nuclear charge by one, thus becoming element 93.

$$_{92}U^{238} + {}_{0}n^{1} = {}_{92}U^{239}$$
$$_{92}U^{239} = {}_{93}X^{239} + {}_{1}e^{0}$$

The new element (designated as "X" by us) has a further activity. Another electron is thrown out and we get element number 94 (designated as "XX" by us).

$$_{93}X^{239} = {}_{94}XX^{239} + {}_{1}e^{0}$$

Element $_{94}XX^{239}$ was expected to emit a helium nucleus ($_{2}He^{4}$), and thus return to $_{92}U^{235}$, but it seems to be rather stable.[61] So now we can say that elements 93 and 94 can at least be produced artificially. It has also been suggested that there is

[60] *Phys. Rev.* 57, 748, 1940.

[61] Here is a sample of statements appearing before these latest experiments: "It is not clear why no atoms of atomic number greater than 92 are found in nature. The properties of the heaviest known nuclei do not suggest that all such atoms would be extremely unstable so that some reasonably long-lived alpha-emitting transuranic atoms might well be expected. Further, the absence of U^{236} is puzzling, for one would expect this nucleus to be at stable as U^{235} and U^{238}. It is striking that the periodic table of the elements ends with the only one that gives nuclear fission with thermal neutrons. This is possibly more than a coincidence and may be the clue to the explanation of the missing atoms." *Phys. Rev.* 57, 157, 1940.) Cf. also *Phys. Rev.* 57, 950, 1940; 58, 672, 1940.

a possibility of a second rare earth group starting with Uranium and going up into the transuranic elements.[62]

Roll Call of the Elements below Uranium:—There is no evidence for the stable form of element 43 (masurium), nor for element 61 (illinium). However, a radioactive form of number 43 has been found by Segre. There is clear evidence for element 85 (called eka-iodine by some);[63] F. R. Hirsch Jr.[64] has discussed the status of element 87. There is evidence for the existence of the unstable atom, some of it as early as 1913. F. R. Hirsch Jr. has again made a search for the stable atom of element 87 with negative results.[65] This leaves number 61 still missing.[66]

Contraterrene Matter:[67]—The nature and structure of matter as here described has been called "terrene." The hypothesis has been put forward by some that "contraterrene" matter may be a distinct possibility.

Contraterrene matter would have neutrons and negative protons in atomic nuclei and positrons in the extra-nuclear regions. Outside of these electrical changes, it would be strikingly similar to terrestrial matter. It would be impossible to detect it spectroscopically in the rest of the universe since no difference in spectra would exist. However, if it would ever interact with terrene matter there would be that same conversion into energy that now occurs between positron and electron upon mutual interaction.

It does not seem to exist in the solar system. Perhaps

[62] *Phys. Rev.* 60, 184, 1941.

[63] Artificially produced radioactive element 85 and some of its chemical properties are described in *Phys. Rev.* 57, 1087, 1940.

[64] *Phys. Rev.* 51, 84, 1937.

[65] *Phys. Rev.* 63, 93, 1943.

[66] *Science*, 91, 327, 1940.

[67] References are given in the *Astrophysical Journal*, 91, 257, 1940, which also contains an excellent sketch of the question.

meteors [68] and comets, if they have their origin outside our system, might be thus constituted. However, at present we do not know. If this would help explain the positive excess in cosmic radiation is doubtful. Anyway it is physically possible, although why matter would be constituted differently elsewhere is again not known. It resolves itself into the old difficulty of why the positive charge is associated with the heavy nuclear particle, and why we have not as yet found the negative proton. However, nuclear physics is a young science, and it is not so long ago that we thought positive electrical charges were associated exclusively with protons. Now we know that it is also found in positrons and positive mesotrons. So the hypothesis of contraterrene matter may perhaps repay watching. Philosophically, it would raise several interesting questions.

Degenerate Matter:—Matter as we ordinarily know it has quite a few "special" properties as distinguished from the "general" properties found in its definition. So in our discussion of "special" properties, it might be well to look around and see if matter is ever found in a state where it is largely stripped of its "special" properties.[69]

The mass of the earth is usually estimated at about 5.974×10^{27} grams.[70] The sun has a mass which is about 332,000

[68] Quite a few articles and a bit of discussion has taken place on this. Some of the references are given: 'Contraterrene Meteorites' (*Popular Astronomy*, 49, 381, 1941); 'Cosmic Rays and Comets' (contraterrene bodies?) *Phys. Rev.* 58, 1010, 1941); 'Meteorite Craters and the Hypothesis of the Existence of Contra-terrene Meteorites' (*Popular Astronomy*, 49, 99, 1941); a rejoinder to this article appeared as 'Contraterrene (?) Meteorites' (*Pop. Astronomy*, 49, 215, 1941); a reply to this was listed as 'Contraterrene Meteorites' (*Pop. Astronomy*, 49, 265, 1941), etc. . . . Also *Popular Astronomy*, 51, 339, 1943.

[69] Some use the word "degenerate" in this connection somewhat differently. E. g. "Within them (the white dwarf stars), the electrons are defienerate—jammed together as closely as the quantum laws permit, and further contraction is impossible." (*Science*, 92, 26, 1940.)

[70] This is not such a good procedure as it tends to confuse mass and weight—which are two distinct although related concepts—but it may serve to give a rough idea anyway.

times that of the earth. Now the factor which is of interest here is the tremendous internal pressure at the center of gravity—due to the mass of the outer layers. Long before the center of gravity is reached, the conditions are too "hot" for many of the orbital (especially the outside ones) electrons to hold on.[71]

Now even in ordinary stars the density is not uniform. The matter is in a gaseous state throughout due to the high temperature. The outer stellar atmospheres have a tenuity which would make our finest "vacuum" look somewhat sheepish. Conversely, there is a large concentration of matter near the center of the star. Many stars have as much as 50% of their mass concentrated within $\frac{1}{10}$ of their radius (from the center out). Other stars have somewhat abnormally large central condensations—having about 90% of their mass within $\frac{1}{10}$ of their radii.[72] This means very high central densities.

"The neutron hypothesis was first introduced by Walter Baade and myself (Fritz Zwicky)[73] in an effort to account for the tremendous liberation of energy of supernovae.[74] We sug-

[71] Remember the orbital electrons are held to the atomic nucleus by its positive electrical charge. This is only a limited force and decreases in intensity with the distance. If an electron is given sufficient energy it can break away from the nucleus and resist any attempts to recapture it.

[72] *Phys. Rev.* 55, 791, 1939. There are chiefly the red giant stars.

[73] W. Baade and F. Zwicky, *Proc. Nat. Acad. Sci.* 20, 259, 1934 and *Phys. Rev.* 45, 138, 1934 and 46, 67, 1934; F. Zwicky, *Scientific Monthly*, 40, 461, 1935. Cf. also G. Gamow, *Atomic Nuclei* (1937), p. 234; L. Landau, *Nature*, 141, 334, 1938.

[74] Supernovae are stars which flare up rather suddenly and at their maximum attain tremendous brightness. The number of supernovae *known* at the beginning of 1940 was 30. (*Publ. of A. S. P.* 52, 10, 1940). Several have been added since then. The absolute photographic magnitude of the supernova in IC 4182 was — 16.6 which is about 600,000,000 times brighter than the sun. However, it did not look so bright to us because it is 912,000 parsecs away, which is the same as 17,424,617,484,800,000,000 miles. This is also equivalent to 2,964,000 light years, so if light has travelled constantly at the constant velocity of about 186,200 miles per second, this event happened 2,964,000 years ago. Astronomers are really catching up with their ancient history. The absolute photographic magnitude of IC 4182 supernova is taken from *Ap. J.* 88, 417, 1938. Other absolute magnitudes of other supernovae are given by W. Baade in *Au. J.* 88, 295, 1938.

gested the existence of stars and cores of stars the average density of which is comparable with the density of matter ordinarily encountered only inside of atomic nuclei. With the designation "neutron star" we do not wish to imply, however, that such a star is to be regarded as a giant nucleus composed of separate neutrons of precisely the same character as free neutrons. We only suggest, that, in contra-distinction to ordinary stellar matter, in neutron stars already minute regions whose linear dimensions are larger than $2.8 \times 10\text{-}13$ cm. are electrically neutral." [75] Zwicky then goes on to suggest that supernovae represents rapid transitions of ordinary stars into neutron stars.

There is a class of stars known as the "white dwarfs." [76] They have a rather high surface temperature, rather moderate stellar mass, and a small radius. This means high density. Thus the companion of Sirius has a density so great that if we could get a cubic inch of its matter to the surface of the earth, it would weigh about three tons. Others have still higher density, one going as high as 9000 tons per cubic inch.[77] Cernuschi [78] says

[75] *Ap. J.* 88, 522, 1938.

[76] "The 'white dwarf' stars are the most numerous of all classes of stars except the red dwarfs, if the count is made, as it should fairly be, in a given volume of space. . . . In white dwarfs almost all energy—gravitational, nuclear, etc.—has been radiated away into space and exhausted, and nothing more can happen . . . Within them, the electrons are degenerate—jammed together as closely as the quantum laws permit, and further contraction is impossible" (*Science*, 92, 26, 1940). Perhaps there is no hydrogen in the entire star. Certainly it seems that all major sources of stellar energy have been exhausted, and either considerable gravitation contraction or internal collapse has taken place. (Cf. *Phys. Rev.* 65, 51, 1944.)

[77] *Science*, 90, 14 (Suppl.), 1939, Dec. 22. The star with the density of 9000 tons per cubic inch is known as "Wolf 457." The sun's mean surface gravity is 27.89 times that of the earth. Wolf 457 has a surface gravity 55,000,000 times greater than the sun. A cubic inch of its own matter would weigh about 9000 tons at the earth's surface. At the surface of this star, it weighs a mere 495,000,000,000 tons. Its diameter is only about 3000 miles, while its mass is 60 times that of the sun. Consequently its mean density is 500,000,000 times that of water. Yet it does not offer any special difficulties to modern atomic theory which must explain the condi-

that D. S. Kothari [79] was the first to introduce the neutron into the theory of the interior of white dwarf stars. However, it seems he did not consider a pure mixture of neutrons, but rather one of protons, neutrons, and electrons. In atomic nuclei, the ratio of neutrons to protons is about as one to one in helium and the lighter nuclei, and then it goes up gradually to about 1.6 to 1 for uranium. Too drastic a change in this ratio (at least in atomic nuclei under ordinary conditions) will cause an internal adjustment—either electron or positron emission—to more or less reestablish the normal ratio. However, in stellar interiors where conditions of temperature, pressure, particle separation, and energy conduction are drastically altered—supernovae [80] and white dwarf stars probably being extreme cases—these conditions may not prevail. If these neutron cores of stars exist, then we should have large aggregates of matter devoid of almost all "special" properties which we ordinarily associate with matter with which we are familiar.

C. *Molecular or Chemical Changes.*

Here it becomes a problem chiefly of considering the orbital electrons and mostly the outside ones in heavier atoms. A general survey of the types of chemical reactions found was given previously. To go into them again and also other subjects would lengthen this sketch too much.[81] However, one point should receive some consideration here because of its general importance in this section.

tions of matter in "cosmic crucibles" as well as in terrestrial laboratories. (Cf. also *Scientific Monthly*, 51, 193, 1940.)

[78] *Phys. Rev.* 56, 450, 1939.

[79] *Proc. Roy. Soc. A.* 162, 521, 1937.

[80] *Phys. Rev.* 56, 120, 1939 and 55, 374, 1939.

[81] Already "Wave Mechanics," "Theory of Forces," etc. has been skipped. Moreover, it would take detailed excursions into the whole subject of X-rays, atomic and molecular spectra, etc., which would require rather extensive treatment.

The Problem of the "Special" Properties of Matter.

In the scientific definition of matter are mentioned those properties which we might call "general," i. e., they are found in all types of matter. There are particles which have only these properties, e. g., the neutretto and the neutrino, and that is why their very existence is so hard to verify experimentally. The neutron has the specific nuclear force in addition to the general properties. When it comes to chemical properties, however, we would like to know if there is some underlying physical property or cause which would be (scientifically) responsible or would be the general cause or source of the chemical properties—since these constitute most of the "special" properties of matter, even if not the most fundamental.

When we mentioned what it was that distinguishes one element from another we said it was the number of protons in the nucleus, or perhaps more accurately, the net positive charge of the atomic nucleus. Although for the formal manifestation of many properties, the resulting electrons and their arrangement in the extra-nuclear regions of the atom were often necessary. Now there are some difficulties to this theory, as for instance, in the deuterium nucleus (heavy hydrogen atom with one proton and one neutron). But with the discovery of the electrical quadruple moment of the deutron, this objection has disappeared. For it was known that "heavy" water, which is composed of two deuterons and one oxygen atom, was different from ordinary water which had the two ordinary hydrogen atoms and the one oxygen atom. Thus we are told that "the implication of the quadruple moment is that the force between proton and neutron in the not 'central'"; [82] and again "the positive sign of the quadruple moment of the deuteron shows that the charge distribution is that of a prolate spheroid spinning about its major axis. Most of the other known nuclear quadruple

[82] *Phys. Rev.* 57, 677, 1940.

moments also show this surprising property." [83] So the seeming difficulty that the neutron was contributing or modifying the action of the hydrogen atom in heavy water has disappeared and the non-spherical distribution of the electrical (positive) charge can account for this apparent anomoly.

Thus, as far as the "special" properties (especially chemical) are concerned, there is usually a special electrical configuration of the electrons in the extra-nuclear regions of atoms. This again puts the theory which he previously mentioned [84] on a rather good foundation.

3. The Philosophical [85] Point of View.

This question is a veritable philosophical battleground.[86]

[83] *Phys. Rev.* 57, 692, 1940. [84] *New Scholasticism*, 14, 49, 1940.

[85] The preceding part dealt with the "scientific" point of view. So it might be well to clarify what we mean by "science" and "scientific," as used there. The word "science" was used by the Scholastics as "the certain and evident knowledge of things through their causes." Today the term "science" has a more restricted meaning almost everywhere except in strict scholastic terminology. If we follow the general acceptation of the word today, we should perhaps define "science" as "the certain and evident knowledge of things through their proximate causes, acquired by the natural light of reason." This excludes theology for theology is acquired by the light of reason illumined (assisted) by revelation. Philosophy, also, is eliminated for its formal object (quod) consists in the ultimate causes of things. Other modern authors use terms which are objectionable for various reasons. "Natural" science would include Philosophy. "Positive" science is based on Comte's Positivism. "Purely inductive" science would exclude much of present-day pure Mathematics, Theoretical Physics, etc. The same holds true with "experimental" science, etc.

[86] "But the present volume shall introduce him only to thinkers who had none of the worries raised by the enormous progress in its own domain of modern science. The thinkers of Greece were at once scientists and philosophers. The thinkers of the Middle Ages went one better: they were scientists, philosophers and theologians. Those days—when knowledge despite its originality and depth was so limited in extent that anyone who had brains enough to be an expert in anything might, if he chose, be an expert in everything—are over centuries ago. Leibnitz was the last to make any kind of successful attempt at this kind of encyclopoedic learning; he did not succeed wholly, and every later attempt was that of a charlatan.

The reason is not hard to find. Inorganic [87] matter has a complexity which is almost staggering. Confusion in the existing terminology, e. g., "elements," [88] "atoms," [89] etc., is an additional handicap.

Modern progress in knowledge has been possible only since men began to realize that this boasted mastery of all knowledge was really an obstacle to mental progress."—*Cosmology*, John O'Neill, p. 35 (Longmans Green, 1923).

[87] The name "inorganic" is probably not the best. Probably in the terminology of the old Scholastics "mineral" would be better. But the word "mineral" today has a very special meaning. It is confined to certain elements and compounds in a very definite state. Word meanings change around so fast that it is hard to get one to fit and that is at least partly acceptable both to present-day Philosophers and to Historians of philosophical and scientific terminology. Thus "organic" chemistry today would come under this treatment whereas "biochemistry" would not. Organic chemistry was largely biochemistry until the so-called "organic" compounds were synthetized—the first (urea) by Wohler at Bonn around 1828. Today "organic" chemistry is largely the chemistry of carbon, except (oddly enough) carbon itself, its oxides and a few of its other compounds.

[88] The word "element" causes a lot of confusion. The procedure adopted here is to use the term in its traditional philosophical sense, when applied to a strictly philosophical discussion. In scientific usage, I have tried to dodge it as much as possible, since it has been linked (by usage) to "chemical elements." Our problems go much deeper than this. So we have used the term "fundamental particles," Consequently, as here used, the term "element" in its philosophical sense can include:

(1) Fundamental particles of matter.
(2) Atomic nuclei.
(3) An entire atom, possibly even a chemical "radical," ion, etc.

[89] The term "atom" (and all its derivative terms, atomic nuclei, etc.) can of course cause confusion, if we still regard it as unsplitable, etc. However, a more general view of the term "atom" will lead to a better outlook. As we look over the different socalled "fundamental particles of matter," we do not call any of them "atoms" until we come to the proton. It has an electrical charge and the mass of a heavier particle so it is the first unit that will have the stability enough to show some easily perceptible "chemical" properties. A proton by itself is a hydrogen nucleus. Allow it to capture an orbital electron and you have a hydrogen atom. This electrical charge of the proton can be distorted by the union (through the "specific nuclear force") to one or more neutrons into the general form of (say) an oblate spheroid and thus cause the special properties of "heavy" hydroven (and "heavy" water in H_2). Thus the chemical

A text-book treatment of the subject is not intended here. Definitions and diagrams are inserted only when absolutely necessary to focus the question or for additional clarity.

The Problem of Species:—The first problem is this: What are we to consider as a "species" of corporeal substance. Another phase of this problem is the view we adopt regarding the unity or the plurality of (substantial) corporeal forms. We shall briefly indicate several positions:

1. If we hold that there is only one substantial form possible to any corporeal substance, then:

a. There are four species;—"mineral," vegetal (vegetable), sentient, and human. All differences within these species are accidental and therefore, all changes within these four species are accidental. Substantial changes only occur among the four species themselves, not within one of them; or

b. Every sample of inorganic matter (to restrict it to the topic of this sketch) which has at least one distinguishing necessary accident.[90] In at least one of the states of matter (solid, liquid, gaseous) [91] is a separate species. There are then *at least several* "mineral" species. The "elements" are only virtually present in the "compound or composite"; or

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properties (therefore also classification of atomic nuclei) are not determined by their mass, but by their net surplus electrical charge and the form of its distribution. This latter factor has been detected only for very "light elements" (e. g. H_2).

[90] Using this division:

ACCIDENTS
- contingent (e. g. local motion, etc.)
- necessary
  - non-distinguishing—not characteristic of a body.
  - distinguishing—characteristic of a body, and basis of its classification. (Some call these "specific properties.")

[91] Different necessary distinguishing accidents *indicate* but do not *constitute* different substances. It is, therefore, not Locke's view of substance as a "complexus of accidents" (or primary qualities). A posteriori, we reason to the species of a substance actually observed by its necessary distinguishing accidents.

c. There are four "essential" species:—"mineral," vegetal, sentient, and human. But there are also "sub-species," and substantial changes can occur among these as well as among the four "essential" species.

2. If we hold the plurality of forms is possible at least in inorganic or "mineral" matter (to restrict it to the topic of this article) then:

a. There are four species: "mineral," vegetal, sentient, and human. "Subspecies" could then exist. What is the distinguishing note and how can any distinguishing (for a "sub-species") accident, be recognized? Are there then sub-formal changes? Are these truly "substantial" or "accidental"; or

b. Every sample of "inorganic" matter which has at least one distinguishing necessary accident in at least one of the states of matter is a separate species. The "elements" may then be *actually* present. There are then *at least* several "mineral" species.

It is hard to see how view "1c" could be possible, arguing from its own principles. The substantial form is the principle of being. Only a complete essence of a determined species is capable of existence. A substantial form confers on the prime matter that intrinsic complement which it needs before it can exist by determining it and giving it a specific existence (that is, constituting prime matter in a determined species). If we say that there are only four "essential species" then we must say that substantial changes are limited to changes among these four types. The idea of "sub-species" does not seem to work if one wishes to hold the theory of the unity (unicity) of substantial form, unless we concede that these "sub-species" due to accidental and not substantial differences. A "sub-species" would seem to demand a "sub-form."

In the positions outlined above, there are two different applications made of each of the two different views concerning the unity or multiplicity of substantial forms. The philosophical arguments for and against each view can easily be found in the text-books.

Substantial Changes[92] *in Inorganic Matter*:—This depends on the view we adopt in the previous section. Which are the species of corporeal substance, and what are we to consider a distinguishing necessary accident.

Views 1b and 2b in more detail:

Taking the view in this section that there are true species within the "genus" of mineral or inorganic matter, let us look at the question in somewhat greater detail.

First of all, this view assumes that local motion and color[93]

[92]

Change
- Accidental
  - in quality—alteration
  - in quantity—increase or decrease
  - in place—local motion
- Substantial
  - partial—if only the matter *or* form is changed.
  - complete—if *both* matter and form are changed.

The only case of a complete substantial change that we know of, is "Transubstantiation" in the Holy Eucharist. Therefore, when we use the term "substantial change" we are in this article speaking only of a partial substantial change. St. Thomas often calls a partial substantial change a *formal* change, and a complete substantial change, a substantial change, thus using the latter in a narrower sense than we ordinarily use it today. An agent acts only in so far as it is *in act*, and it must account for any change into a new form; hence the matter, being only in potency never causes a change itself, but always remains as the subject underlying the changes undergone by its active form. But God is pure act—hence He can change both matter and form. Nature has power over half the substance in such an operation, while God has power over the entire substance, both matter and form, or its whole being. Cf. St. Thomas, *Contra Gentiles*, Book 4, Chapter 63.

[93] Color is a very difficult thing to deal with unless we would go into a somewhat more exact and necessarily more lengthy treatment. Simple colors are usually determined by the frequency of the radiation, which is frequently characteristic of a particular type of matter and it alone. But reasoning back from characteristic frequencies to electron radiation fields, etc., is an intricate matter. The same holds for X-rays. Absorption, interference, diffraction, refraction, & Doppler-shift phenomena help to complicate the matter. The problem of monochromatic radiation is difficult enough, but polychromatic radiation increases the difficulties almost beyond bounds. Also helping to make the problem more complicated are the problems of "synthetic" colors, colored objects in motion, colors due to primary and secondary spectral maxima, "Black" and "Gray" body radiation, energy associated with each frequency, color changes by a

in general are contingent accidents, although this is only said with many restrictions.

Let us now examine and see what could be considered substantial changes under views 1b and 2b. Some interactions of the fundamental (scientific) particles are as follows: [94]

$$p = n + \delta$$
$$n = p + e$$
$$m^+ = \delta + \text{neutrino}$$
$$m^- = e + \text{antineutrino}$$
$$e + \delta = c$$
$$c = e + \delta$$
$$c = m^+ + m^- \ (?)$$
$$c + p = m^+ + n \ (?)$$
$$c + n = m^- + p \ (?)$$
$$c + n = n + \text{neutretto} \ (?)$$

Yukawa's scheme for beta-disintegration is as follows: [95]

Compton effect, selective and non-selective scattering, etc. For instance, gold usually is considered to be very yellow, yet very thin films of it are green in transmitted light. Color is not a primary entity like radiation, and color as such usually cannot be perceived by any mechanical means. (Here wave-lengths, etc., are more directly involved, e. g. in "color" filters, photoelectric cells, spectroscopes, photographic films). Color is a phenomenon associated with radiation impinging on certain types of eyes. However, it has a foundation in reality. It should not be confused with the image-forming ability of an eye or lens. We have to be most careful, if we wish to speak exactly about colors. Thus grass looks green to us, not because it absorbs green light, but because it absorbs most of the other colors pretty well, and reflects green light. The action of transmission filters is just the opposite. Combining filters often gives us only those colors transmitted by both, etc.

[94] In the equations that follow, it is always understood that the proper conditions are present. Question marks in parentheses after equations indicate both unobserved (as yet) or only theoretically probable interactions . . . "c" is the symbol for light or better yet, electromagnetic radiation. "hv" would probably be better as a symbol as used here. ("h" is Planck's constant, "v" any definite frequency) However, "c" is shorter.

[95] Cf. *Phys. Rev.* 57, 409, 1940. However, it is still doubted by some. Cf. *Phys. Rev.* 57, 998, 1940. The production of mesotrons by a kind of photoelectric effect and their production by protons in analogy to the emission of quanta by electrons is discussed in *Phys. Rev.* 56, 494, 1939. The conversion of a photon into one or more mesotrons upon collision with an atomic nucleus is discussed in *Phys. Rev.* 56, 500, 1939.

$$n \longrightarrow p + m^- \quad \text{then} \quad m^- \longrightarrow e + \text{antineutrino}$$
$$p \longrightarrow n + m^+ \quad \text{then} \quad m^+ \longrightarrow \delta + \text{neutrino}$$

The scientific differences of the interacting particles is given in the table of scientific data concerning these particles in a previous article.[96] Views 1b and 2b could then consider these differences sufficiently great, and maintain that they are true substantial changes. It would not ordinarily consider bodies in fast or slow motion as undergoing any substantial change, although the rapid increase of electronic mass as its velocity approaches the velocity of light would be a difficulty. However, this latter fact may not be so very certain, so we might label the objection as having only probable value as far as its degree of certitude is concerned.[97]

Taking up nuclear changes next, we come to the question of the "chemical" elements.[98] Views 1b and 2b could consider any of the nuclear reactions given under the sections on "Ordinary Nuclear Changes," "Nuclear Isomerism," and "Nuclear Fission" as true substantial changes.[99] However, some would

[96] *New Scholasticism*, 14, 51, 1940.

[97] Cf. *Phys. Rev.* 53, 511, 1938 ("Review of Classical Experiments on the Relativistic Variation of Electron Mass," by C. T. Zahn and A. H. Spees).

[98] We shall use the word "element" in its ordinary scientific sense here, although later on when we discuss the presence of the elements in compounds, we find it more convenient to switch to the strict philosophical meaning in order to preserve the accepted meaning of the key words in the discussion.

[99] If there is question only of energy changes or changed in the number of neutrons in atomic nuclei, it would hardly be considered a substantial change in either view, with a possible exception, which we shall mention later on. The neutron is frequently considered element 0, because it has no chemical properties. The specific nuclear force operates between neutron and neutron, so it is not impossible to have aggregates of neutrons thus held together as we considered them in the section dealing with "Degenerate Matter." However, under "ordinary" conditions, if two or more neutrons are held together by the specific nuclear force, there is usually an electron emission, and we have then a neutron and a proton (deutron), or whatever the numbers of each particle may be. It might be of interest here to note that the following reactions have not as yet been observed:

$$_1H^1 + {}_1D^2 \longrightarrow 2{}_1H^1 + {}_0n^1$$
$${}_0n^1 + {}_1D^2 \longrightarrow {}_1H^1 + 2{}_0n^1$$

probably wish to restrict substantial changes only to interactions among the ultimate (scientific) particles. Now such a view has much in favor of it, and cannot be lightly brushed aside. However, arguing from the host of new properties these nuclear reactions could also be considered true substantial changes.

One of the perplexing things here is that "terrene" (neutron + proton + electron) matter would be spectroscopically and chemically indistinguishable from "contraterrane" (neutron + negative proton + positron) matter, except, of course, if the two were side by side, and then due to the electrical interactions taking place between particles of like mass but opposite electrical charge, there would be a new deal. However, if we remember that the binding extra-nuclear force is electrical in either scheme (and the law of electrical signs holds in either scheme also) then there is only a swapping of (electrical) signs, which is not so bad except that we must keep our signs crossed.

Concerning chemical changes we might say that views 1b and 2b would probably again divide into schools (but not necessarily as view 1b opposing 2b) in regard to the interpretation of the nature of these changes. Some would confine true substantial changes to the ultimate (scientific) particles of matter, others would extend the idea to include chemical changes. For the benefit of the latter view, it should be remembered that special orbital configurations of the electrons are often necessary for the formal manifestation of chemical properties, and if the remarks made in the section on "The Problem of the Special Properties of Matter" are kept in mind, it will be seen that

There is a curious interaction which is hard to classify. It is the so-called "Oppenheimer-Phillips Process" which consists in bombarding atomic nuclei with deuterons. The deuteron is split at the outskirts of the atomic nucleus as its neutron sticks in the atomic nucleus, but the proton is driven off by (Coulombian) electrostatic repulsion. Now it is hard to say that "heavy" hydrogen (deuterons) have any chemical properties strictly different from ordinary hydrogen in the atomic or molecular (H) state. However, in "heavy" water (D_2O) there is a difference. For a good description of the Oppenheimer-Phillips process, cf. *Phys. Rev.* 57, 866, 1940.

the difficult cases of stereoisomerism and even the quasi-localization of properties in some chemical compounds can be accounted for even scientifically.

Number of Substantial Changes:—This will depend on the view taken concerning where we find substantial changes. The number of changes observed or theoretically possible among the fundamental (scientific) particles of matter are given more or less in a previous section. The number of changes possible in nuclear reactions is somewhat difficult to determine, but the end result is always one of the 94 (chemical) elements (and sometimes also neutrons and radiation). However, the number is not so very small.

The number of chemical compounds is enormous. There are 94 known (chemical) elements. Even after deducting the inert gases, the combining possibilities are enormous.

However, chemical valence would restrict this somewhat, because all the different types will not combine with one another. But different valences could increase it again (e. g. CO and CO_2). We can then add the tremendous possibilities of isomers [100] and the number becomes even greater.

The number of *known* compounds has been (conservatively) estimated (several years ago) to be over 600,000 and the number is constantly growing. Nature certainly is not stingy!

[100] Since isomerism depends on the way atoms are linked together, it might be interesting to add a few examples of the number of isomers possible. Twenty-six isomers have been prepared and their properties recorded for the formula $C_9H_{14}0$. A rather complicated methematical formula has been developed for calculating the number of possible isomers of a parafin hydrocarbon. The results of applying this formula are rather startling and they show that the number of possible isomers mounts rapidly as we proceed to molecules with more and more atoms. There are nine possible isomers (all of which are known) with the formula C_7H_{16}. For the formula $C_{20}H_{42}$ there are 366,319 possible isomers. For the formula $C_{40}H_{82}$ there are 69,491,178,805,831 possible isomers. We should remember that the highest straight chain member of this series which has been so far prepared is $C_{70}H_{142}$ (hepta-contane). Then also we must remember there are only two types of atoms involved—carbon and hydrogen. The subject has numerical possibilities.

However, the purpose of this section is not to dazzle the imagination but merely to point out that there is a slight quantitative difference (as well as a qualitative one) concerning the different possible views on where we find substantial changes.

Conditions of a True Substantial Union and Presence of Elements in Compounds: (Historical)—Present-day bewilderment on these questions is nothing new. So let us very briefly consider some of the views that appear most promising. Aristotle first formulated the theory of hylomorphism, and yet he was none too clear on this problem. Though he taught that "inanimate bodies were a blend in varying proportions of the four elements . . . (still) he seems never to have reached a definite conclusion on the permanence or non-permanence of the substantial forms of the elements in composites. His text when treating directly this problem favors the theory of their non-permanence; other texts of his favor the theory [101] of their permanence." [102] He did teach, however, that "in a perfect mixture the four elements are so completely changed that every part of the mixture is homogeneous with the whole." [103] And "each sensibly homogeneous and continuous lump of non-living matter possessed in his eyes unity of being, and was a single substance." [104] In substantial change, "the quantity of the corrupted body disappears with the outgoing substantial form, and the quantity of the generated body is totally new . . . ." [105] Aristotle also "explains all accidental changes by his theory of matter and form. In such changes, the matter is always an existing individual, and the form is always an accident." [106]

[101] Aristotle, *De Gen.* I, t. 84; II, t. 48; I, c. 10.

[102] O' Neill, *Cosmology*, Vol. 1, p. 142.

[103] O'Neill, *Cosmology*, Vol. 1, p. 105. Cf. Aristotle, *De Gen. Corr.*, I, 10; II, 7; *De Hist. An.*, I, 1; *De Part. An.* II, 1.

[104] O'Neill, *Cosmology*, Vol. 1, p. 117. Cf. Aristotle, *Met.* VIII, 6; *Phys.* V, 3; VI, 1.

[105] O'Neill, *Cosmology*, Vol. 1, p. 116.

[106] O'Neill, *Cosmology*, Vol. 1, p. 103. Cf. Aristotle, *Met.* VII, 13; IX, 7; *De Gen. Corr.* 324a. 15-19.

Alexander of Hales[107] distinguishes spiritual, terrestrial-corporeal, and celestial "matter"; hence it would seem that he rejects the homogeneity of prime matter. He also taught the plurality of substantial forms in all compound bodies, to give sufficient reason for the diversity of perfections in a creature, and to explain how higher forms, in spite of their individuality, may possess determinations found in lower things.[108]

Albert the Great wrote: "We teach that there is one (primordial) matter distinct from the four elementary sensible bodies . . . that out of it as matter, those bodies which are called elements are generated." [109] He also held the permanence of the elementary forms in a compound,[110] and the consequent plurality of forms.[111] "A true mixture is a new homogeneous substance arising out of the alteration of the four elements. . . . The substantial forms of the elements in such a mixture are . . . not wholly preserved, because the same primordial matter cannot be simultaneously actuated by more than one substantial form; not wholly destroyed, because this kind of mixture certainly possesses the properties of the four elements." [112] In defense of this view, Albert writes: "The forms of the elements are twofold, namely, primary and secondary. The primary are those from which comes the substantial being of an element, without contrariety; and the secondary are those from which comes the existence of an element, and activity. And as regards primary forms, they are preserved, as I judge, in the composite

[107] We consider his view here, because many have the impression that the views of Alexander of Hales, Duns Scotus, St. Bonaventure, Suarez, etc., are the same as those of Albert the Great. This is not the case, as this example shows. Considering the other views at length would take up too much space.

[108] De Wulf, *Hist. of Med. Phil.*, Vol. 1, p. 373.

[109] *De Gen.*, II, tr. I, c. 4.

[110] De Wulf, *Hist. of Med. Phil.*, Vol. 1, p. 401.

[111] *De Coelo*, III, tr. 2, c. 1, 8; *De Gen.* I, tr. 5, c. 6; II, tr. 2, c. 15, text. 48.

[112] O'Neill, *Cosmology*, Vol. 1, ch. 5, p. 143.

. . . and as regards secondary forms, . . . they do not remain in act, but in potency." [113]

St. Thomas (at least in most places) argues emphatically against a plurality of forms.[114]

Nys [115] seems to reduce the Thomistic position to three propositions, with composition of matter and form as a corallary:

a. Simple bodies and chemical compounds are beings endowed with substantial unity, specifically distinct from one another, and naturally extended.[116]

b. These beings possess active and passive powers which belong to them in virtue of their substantial essence, and are indissolubly bound up with it.[117]

c. They have an inherent tendency to realize by the exercise of their native energies certain special ends.[118]

Thomas Harper [119] sets forth the words (and their translation) of St. Thomas, touching upon the nature and constitution of compounds—summarized under seven headings. Then under nine headings he sets forth principles contained in the writings of St. Thomas. It is almost impossible to present all the views here. This is a fair sample.[120]

[113] *De Coelo et Mundo*, Lib. III, tr. 2, c. 1.

[114] St. Thomas: *Summa Theol.* I, q. 76, art. 3, 4, 6, ad I, 8; III, q. 1, a. 1, ad 1. *Contra Gentiles*, Lib. II, c. c. 57, 58. *Quaest. Disp. de Spir. Creat.*, a. 1, ad 9, a. 3. *Quaest. Disp. de Anima*, a. 9 et 11. *Quodl.*, I, a. 6; XII, a. 5. *De Subst. Separ.* c. 6. *De Plural. For.*, V, init., *De Potentia*, q. 3, a. 9, ad 9, etc. Pesch, *Inst. Phil. Natur.*, pages 225 ff.; Mercier, *Manual of Mod. Schol. Phil.*, Vol. 1, p. 78, etc.

[115] Mercier, *Man. of Mod. Schol. Phil.*, Vol. 1, p. 73.

[116] *De Nat. Mat.*, c. 8; *De Princ. Nat.; De Plur. For.; De Mixt. Elem.* (St. Thomas).

[117] St. Thomas: *De Ente et Essentia* c. 8; *Sum. Theol.* I, q. 77, a. 6, ad 3.

[118] St. Thomas: *Contra Gentiles*, IV, c. 19.

[119] *Metaphysics of the Schools*, vol. 2, Appendix A, Chapter 7, p. 734 (edition of 1881, MacMillan, London).

[120] An excellent short sketch may be found in a thesis submitted at St. Gregory's Seminary, Cincinnati, Ohio, by Paul E. Conrad (in 1937) entitled "A Comparative History of the Origin and Development of Substantial Form in Inorganic Beings."

4. Conclusion.

Considering all sources of certitude, the most certain solution we have is that of the human soul being the substantial form of the body, although strictly speaking, one probably cannot say that the Council of Vienne endorsed the strict Thomistic view of matter and form, as the decree was directed against some other ideas . . . However, somehow the human being is usually considered as possessing the matter and form composition in a very fine manner.

Now arguing "backwards"—if the human soul (the form) takes over all the activities of the parts of the body, what then makes it so incomprehensible to assume the same thing in a form in inorganic matter. Neither hylomorphism, hylosystemism, or any other theory can ignore at least the more certain of scientific facts involved.

Moreover, if we analyze things carefully, we can see that if the actual existence of contra-terrene matter is ever verified, there will not be the slightest difficulty in the seeming identity of properties arising from different constituents, if we remember what was said concerning the underlying physical property or cause which would be (scientifically) responsible or would be the general cause (scientifically, again) or source of the chemical properties.

If in a man's body all the chemical and physical properties continue which are found in inorganic matter, then why could not a form further down the line do the same thing, in its own proper manner. Thus in the so-called "tracer" atoms we have the phenomenon of atoms (the nuclei of which have been artificially "excited" so that they show temporary radioactive properties as far as their nuclei are concerned) being assimilated into the human body in the ordinary manner as their chemical properties are the same. These atoms can then be "traced"—due to their nuclear radioactivity—as they partake

in the various functions or as they become parts of the body. Why cannot this type of activity also be admitted in the inorganic world?

The old difficulty, of course, is to reconcile the large amount of residual activity and even residual "particles" in the new "compound." All the theories outlined have their strong and weak points, but all their explaining has to be covered in the long run by the same type of theory that covers the human body and the human soul. Many of the problems involved are common, hence any "ad hoc" theory (e. g., for the inorganic alone) would seem useless.

The so-called "tempered" activity of the elements in the compound is a thing which has many difficulties, and our imagination with its countless phantasms does not help the problem. Briefly stated, the only activities "tempered" are the ones which would tend to render the new compound unstable or destroy it, or make its existence unstable. Thus, as was pointed out in an earlier article, nuclear radioactivity is almost entirely unaffected by chemical change; in elements of higher atomic number, X-ray spectra of the inner orbital electrons are only very slightly affected, whereas molecular spectra (involving the coupling features) are.

Another difficulty is the apparent union between "particles" or whatever we wish to call them, that are separated or even pursuing orbits in a field of force. However, the same difficulty is apparent in the human body. Apparently, quite a number of difficulties arise not so much out of the union itself, as from our lack of understanding of the various activities involved. So in our choice of theories, it is good to remember that some have less difficulties on first inspection, but usually this "escape" is only temporary. Thus while nature performs all these changes with effortless ease, our comprehension of these operations is far from complete.

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FREEDOM OF THE WILL AND PSYCHOLOGY

THE PAPERS published in the Proceedings of the American Catholic Philosophical Association are a mine of suggestions for further studies which is no doubt too little exploited. As I chanced to look through the 1940 number, I came again across a discussion which at the time had seemed to me particularly worthy of being followed up. I refer to Dr. John W. Stafford's presentation of the problem of "Freedom in Experimental Psychology."

Dr. Stafford's thesis was that the freedom of the will cannot be demonstrated by experimental psychology, "because experimental psychology, being a science, is cast in the frame-work of fact-law theory: the careful observation of facts, the syntheses of those facts into general laws, and the explanation of those laws by theories that can be verified in concrete experimental situations." Now, the argument goes on "it is impossible to establish that all possible determining antecedents have been eliminated in a given voluntary act, as the number of possible antecedents is much too great to be controlled by any method known to science." Dr. Stafford therefore suggests that "the best refutation of determinism is to show that the problem is altogether outside the competency of scientific investigation . . . since no two situations present the same pattern of antecedents." If the freedom of the will cannot be established by experimental psychology, neither can philosophical determinism. But cannot the problem of the will at least be proved by the technique of introspection? "Not as long as the validity of introspection as a scientific technique is denied as it is by most contemporary psychologists." So Dr. Stafford concludes: "Freedom of the will is exclusively a metaphysical problem . . . and we should elaborate a more cogent metaphysical proof for freedom than the

ones generally given in the text books." In examining more critically the whole problem of the possibility of a scientific psychology, we should make more precise the distinction between philosophy and science and the question of the correlations between the two; and finally, understanding that freedom of the will is exclusively a metaphysical problem, we should follow up as is seldom done " the splendid Thomistic argument that man must be free because he is rational."

To one who was led to approach the problems of philosophy through the necessity of reasserting humanism, as opposed to naturalism, because of their opposition in literary history, the Thomistic argument that man must be free because he is rational has long had a singular appeal. For to try to reassert that man is distinct in the midst of nature cannot but bring home the full significance of the fact that the dividing line between man and the rest of nature is his capacity to conceive universals, and hence to escape from the determinism of particulars. St. Thomas' words: " Necesse est quod homo sit liberi arbitrii ex hoc ipso quod rationalis est " (Sum. Theol. I. p. 83. a. 1) could perhaps be even more pertinently translated: " Because man is rational, he necessarily has free will." The humanist might then say: The freedom of man consists in the possibility of choosing a particular in the light of a universal. Or: Because man, being rational, can conceive universals, he can consciously deliberate and, thus escaping from the domain of the particular, he can choose a possible behavior in the light of an abstract principle.

We must grant that man often acts otherwise. He acts otherwise before " the age of reason," or rather in proportion as he is or remains incapable of conceiving or remembering abstract principles. He acts otherwise, even after reaching the age of reason, probably most of the time, because he acts from acquired habits, or under the impulse of appetites for particular goods which appeal to him as final ends. As long, or as often as he thus acts, he leads a merely animal life. Man acts as a man only

when he utilizes his intellect, conceiving or holding a universal principle at the focus of attention, and his reasoning powers consciously confronting a possible particular behavior with that principle.[1]

This holds in all domains, even in such a simple one as that of grammar. If a student writes: Les livres que j'ai lus, because he has seen that sentence often enough and his perceptive and retentive powers are sufficiently acute for the *s* to have become automatized, he performs an animal act, he acts through an acquired reflex. But if he hesitates at *lu* and then recalls the principle of the agreement of past participles, he performs a human act. In the first case he proved that he had automatic power. In the second case he shows that he has knowledge. Such knowledge is not necessarily power. Many students know rules but do not apply them, while full power can be said to exist only with the automatization of the response called for by the rule. Is the student free not to apply the rule when he knows it and it conscious of the necessity of its application? Yes, theoretically, but practically no, because other motives will be present such as the advantage of writing correctly.

Let us then come to a higher case. The thirsty man or animal before a pitcher of water will be determined to drink. A man before a fourth cocktail may be determined to drink because of acquired habit. He has practically lost the capacity of acting rationally. But a normal man in the same situation may consciously deliberate, conceive or remember the abstract principle that drunkenness is bad, and reason that this particular act of drinking a fourth glass will bring drunkenness. Because he can so reason he becomes free to abstain. He is freed from the unconscious determinism of the particular by the possibility of the conscious contemplation of an ideal.

It should be noted that freedom of the will though due to our

[1] This is corroborated in theology which teaches that only in such a situation can there be a mortal sin.

capacity to conceive an ideal which frees us from the determinism of the particular does not mean that we are determined by that ideal, but that we are capable of recognizing the truth of that ideal and of adhering to it. Freedom is the conscious acceptance of an ideal as a guide to action, the conscious acceptance of some aspect of God's order as opposed to the possible determinism of some particular bodily appetite the indulgence of which might constitute a violation of God's order. And this means that a free because rational act, behavior according to some aspect of God's truth, is an act of love. Thus only can we understand the full import of saying that we are necessarily free in proportion as we are rational. We are made to know God and therefore to live in God's order. We are free to live in God's order in proportion as we know, because that knowledge saves us from perceiving particular goods as final goods, and hence from being determined by them. It is the knowledge of God's order that makes us free. It is that knowledge which makes us love.

Why then are we so weak in governing ourselves according to universal principles? Because universal principles are abstract and particular goods concrete. St. Thomas saw so well that in a compound of body and soul the soul is at a disadvantage, because of the pull of the sensual appetites directly stimulated by concrete particulars that he ascribed to grace the state of original justice. Likewise theologians, who stop to consider the question, recognize that if man had been created and left in the natural order God, in His justice would have given him help to resist the pull of the sensual appetites and to shape his behavior according to rational principles. If we fail to act rationally, it is in so far as the perfection of rationality needs the further perfection of grace.

With such discussions to what domain have we come? Evidently we are no longer in that of mere animal psychology but in that of humane or humanistic psychology. Is this humane

psychology wholly metaphysical? Here we come to the questions which Dr. Stafford raises. The naturalist would have us believe that questions of human behavior are wholly physical. Should we say that, on the contrary, they are exclusively metaphysical, or rather do we not have " to make more precise the distinction between philosophy and science and the question of the correlation between the two," especially in relation to the study of man.

Science in the way Dr. Stafford defines it means strictly physical science and for him experimental psychology is strictly a physical science. If so should it not rather be called experimental physiology? Evidently as such it can have nothing to say about the freedom of the will which is due precisely to the possibility of an escape from the physiological. It can have nothing to do with the study of man as such.

Does this mean that the study of man as a free being belongs exclusively to philosophy or more particularly to metaphysics. It would not seem so, since man has in him both physical and metaphysical elements united in one compound. What we need is evidently a distinctly humane or humanistic psychology recognized to be both physical and metaphysical which will devise a special methodology through which both the physical and metaphysical aspects of man can be studied.

Is introspection the answer? Dr. Stafford calls our attention to the fact that it is widely challenged as a legitimate method. But as he admits there may well be further study of that question. Since consciousness is a fact of human nature to neglect the study of its immediate data by introspection would be to dismiss facts which fall under perception as truly as objective facts, and therefore could lead to the accusation so often made by Irving Babbitt, that to dismiss the immediate data of consciousness is to become merely partial positivists.

But immediately it may be further suggested that in the study of his behavior, man is not limited to introspection because by the very fact that man is a physical being, his immediate data

of consciousness can be projected into the physical world and become objective facts. To see it we need only to return to our simple example of the agreement of past participles. It may be by introspection that I know that I think of a rule or abstract principle before settling the case of an agreement. But such an introspectively known behavior is certainly objectively actualized if my rule is written in a grammar and I look it up. And I can make quantitative studies of such behavior: How many times will students with given I. Q.'s have to look up the rule or rules of increasing difficulty? How many times do they have to look up such rules after certain types of teaching, and how many times after other types? Do certain ways of teaching inhibit the development of rapid choice? In fact must not a humane or humanistic educational psychology be based on such types of studies?

And in a higher domain: It may be that it is by introspection that I know that I do not take the fourth cocktail because of a moral principle in my consciousness. But such moral principles are codified and taught, and it should not be impossible to make objective studies as to behavior depending upon codified principles or the ignorance of principles. In fact if such studies were impossible we could not have a humanistic "social work." We could only have social work based on a physiological psychology which would limit it to the study of neural disturbances and of the impact of environmental conditions. In social and literary history it should also be possible to chart the behavior of given groups in the light of the prevailing moral codes. It cannot be irrelevant to know for instance when stoic thought was dominant in modern times, or to what extent voluptuous neo-paganism was the real ideal of certain classes at certain periods.

The question may even be raised whether it is not possible to note the action of free will in the purely physical order and hence to study it in the experimental laboratory. Is it not true that man can interfere at least in some instances with physical

processes which naturally determine him as in the case of inherited reflexes? It is clear that we cannot interfere volitionally in a direct way with the action of the heart; but it is also evident that though breathing is an inherited reflex we can choose to stop breathing. It is safe to say that a mere animal cannot choose to do so. And we can choose to interfere with many other inherited reflexes, including those of the heart, though we must do so indirectly. In fact the practice of medicine is largely based on such possible interferences.

In this connection it should be conclusive to note in favor of the freedom of the will that, as a matter of fact, the study of all the physical sciences depend on such free interferences with the physical determinisms in nature. As Lynn Harold Hough brings out in the *Christian Criticism of Life*: "Science deals with determined mathematical relationships. It cannot touch that which transcends the determined aspects of existence . . . Properly defined it deals with the subhuman . . . And yet it is only by means of freedom that the scientist can do his work . . . Man's capacity to establish standards and to set about living in loyalty to them belongs to that free world which science cannot analyze but without which science could not exist" (pp. 102-104). Evidently, since the scientist must consciously choose the object of his investigations and the means of carrying them out. So the laboratory of so-called experimental psychology, which, in so far as it is really a laboratory of experimental physiology, cannot prove the freedom of the will, could not even exist if the freedom of the will did not, since all its experiments are due to the free choices of the experimenter both as to ends and as to means. Every scientific laboratory is a projection into the objective world of man's capacity to choose freely because rationally.

But we need to go further. To those who believe in Revelation there is a higher domain to explore than even humanistic as opposed to animal psychology. There is the psychology or super-

psychology of supernaturalized as opposed to integral humanism. Integral humanism and its psychology should include the possible action of the help that in the natural order God would in justice have given to man because in a compound of body and soul the concrete passions are stronger than the abstract principles which the reason can oppose to them. But Revelation tells us that man was raised to the supernatural order so that this help which God would have given to man in the natural order is replaced by the free gift of supernatural grace. The divisions now existing between men are not fundamentally those existing between the Christian churches but those between naturalists, humanists, and the believers in supernaturalized humanism. As, according to the latter, man's present state is in terms of his having been raised to the supernatural order, we do not really study man as he is, and the action of his free will as it really functions, unless we try to take into consideration the workings of grace. The Stoic would say that the man before the fourth cocktail which he knows will make him drunk can refrain from drinking it by sheer power of the rational will. The believer in supernaturalized humanism would say that he may need an actual grace.

Is the study of the working of grace in man in relation to free will wholly impossible? Is it impossible to study it experimentally or as it functions or may be made to function in given cases? No, since the principles on which it works can be objectively codified and since their application functions in the objective world, since in many instances physical acts must be performed to obtain grace such as prayer, the reception of the sacraments, and the avoidance of occasions of being determined by the sensual appetites. In fact any treatise on the spiritual life is but a record of such experimentation, as are also the lives of the saints; and a spiritual director must be an adept in the applied psychology of supernatural humanism.

To sum up. If neither freedom of the will nor determinism

can be established by physiological experiments, the freedom of the will can nevertheless be objectively studied. The proof of the freedom of the will is not wholly a metaphysical problem because freedom of the will is exercised in the physical world. A great deal can be done to pin down its action as a factor of behavior in specific cases both actual and historical. Otherwise there could be no science of man. On the other hand, the science of man is not purely a physical science. It must be ready to recognize both the metaphysical and physical factors: physical actions according to abstract principles, constantly evident in human behavior. The freedom of the will is the freedom of an ego capable of conceiving universals. Its exercise consists in choosing a particular behavior in the light of such universals. These universals can be exteriorized into objective facts, and the particular acts performed according to them are also objective facts. Therefore the exercise of the will can be studied experimentally by a case-system.

It cannot be said that such case-studies are impossible because "it is impossible to establish that all possible determining antecedents have been eliminated in a given voluntary act as their number is much too great to be controlled by any method known to science." This cannot be said because the exercise of the rational will, or the choosing of a particular in the light of a universal, is precisely the rising out of the domain of such particular determining antecedents. It therefore makes no difference how numerous they may be. Why I go to a certain place in a given instance may be incapable of determination because there are too many or too obscure antecedents. But this no longer holds if I choose to go and actually go to a certain place because of an abstract principle. What the physical laboratory may contribute to the study of such a humane or humanistic psychology may remain an open question.

We need to study experimental physiology because man is partly an animal. We need to study a humane or humanistic

psychology because man is a rational being, and because his rationality begets free will. We may do so even if we hold that man was raised to the supernatural order because this does not mean that he may not perform many free acts without the help of grace. In so far as we believe that man was raised to the supernatural order, we need further to study the readily available objective cases of the cooperation of the free will with grace. Our psychological studies must then range, through case-studies, from the domain of physical science to that of humanism, and eventually to that of supernaturalized humanism. Thus only can we be truly positivistic, because thus only can we take into consideration all the facts pertaining to man.

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PLATO AND ARISTOTLE

A Contrast Between Their Mathematical Outlook.

THE PROGRESS of mathematics in the fourth century B. C. prompted the attempt to organize its various branches and to incorporate its principles in a wider philosophical synthesis. The alternative methods offered by arithmetic and geometry for the solution of problems, required a rationalization of the intimate relations thus revealed between these two sciences. Emerging from the realm of the discontinuous, where it was enshrined by the Pythagoreans, the idea of number used more and more the implications of its early fusion with spatial intuition and endeavoured to express the continuous character of geometrical notions. This mathematical synthesis was encouraged by the systematization of the theory of irrationals, by the establishment of the doctrine of loci requiring the manipulation of various types of functions, and by the elaboration of methods involving the infinite. Thus, it is the variety of the technical expressions of spatial intuition and the methodological application of the infinite, which allowed number to assume a more universal significance. The elaboration of the Platonic doctrines corresponds to this synthetic development of mathematics.

It may be, that if this movement were allowed then to develop further without hindrance, Greek science and philosophy might have taken a turn very much different from the one which history has placed on record. In fact, the successful development of Plato's basic intuition might have given to mathematics a formal flexibility and an independence of sense perception which were to be essential in the later formation of the concepts and methods of the calculus. Moreover, his creative cosmogony with its insistence on mathematical relations, might have inspired the gradual establishment of a mathematical physics of an idealist

type. That is why a number of modern commentators go as far as to maintain that the recent views on the relations between logic, mathematics and physics, are foreshadowed, if not preformed, in the Platonic doctrines.

In most cases, such enthusiastic opinions are brought into greater relief by means of adverse criticism against Aristotle, who is accused of having blocked the way to the early development of the calculus, of experimental sciences, and quantitative physics. Thus, it is said that Aristotle remained outside the synthetic movement in mathematical theory which was taking place in his days. And because he was not technically a mathematician, he is accused of having misunderstood the evolution of the mathematical views of his contemporaries, and of having failed to estimate the value of their discoveries.[1] It is even asserted [2] that the authority of Aristotle held back for two thousand years the remarkable attempt to arithmetize mathematics which Plato sought to complete.

In this connection, Whitehead writes that Plato and Pythagoras stand nearer to modern science than does Aristotle. "The two former were mathematicians, whereas Aristotle was the son of a doctor, though of course, he was not thereby ignorant of mathematics. The practical counsel to be derived from Pythagoras is to measure, and thus to express quality in terms of numerically determined quantity. But the biological sciences, then and until our own time, have been overwhelmingly classificatory. Accordingly, Aristotle by his logic throws the emphasis on classification. And the popularity of Aristotelian logic retarded the advance of physical sciences throughout the Middle Ages. If only the Schoolmen had measured instead of classifying, how much they might have learnt!" [3]

[1] Rey, *La Maturité de la Pensée Scientifique en Grèce*, pp. 332, 335.

[2] Toeplitz, *Das Verhältniss von Mathematik und Ideenlehre bei Plato*, pp. 10-11.

[3] *Science and the Modern World*, p. 3.

Similar opinions are expressed by many scholars, without any discrimination of the historical facts available. Thus, we are told that Aristotle's "dead hand" held back the advance of physical knowledge, because the prestige of his work "did much to turn Greek and medieval science into a search for absolutely certain premises, and into the premature use of deductive methods."[4] Or again, it is asserted that the Aristotelian logic accounts for the neglect of experience and the unprogressiveness of science for nearly two thousand years, because "the whole theory of science was so interpreted, and the whole of logic was so constructed, as to lead up to the ideal of demonstrative science, which in its turn rested on a false analogy which assimilated it to the dialectics of proof."[5]

Such views, however, are both unfair and unwarranted by the analysis of facts. To begin with, Aristotle cannot be responsible for the use or the misuse which his successors made of his works. They had before them both the doctrines of the Academy and those of the Lyceum. No authority forced them to show their preference, save their reason, their interests and the technical circumstances of scientific research. To be sure, in order to prove that Aristotle was averse to the scientific developments implied in the Platonic conceptions, it is necessary to show first that Greek mathematics and physics were actually capable of developing technically in those directions. Such a proof, however, cannot be given. Plato did not suggest any practical and immediate means for such developments; and neither the mathematical symbolism and techinque of the Greeks, nor their physical conceptions and means of observation, justified a mathematical treatment of the Platonic intuitions. On the contrary, Plato's successor's and the neo-Platonists insisted more on the mystical aspect of his doctrines, than on their scientific implications.

[4] Dampier-Whetham, *History of Science*, p. 39.

[5] Schiller, in *Studies in the History and Method of Science*, p. 240 (ed. Singer, 1917).

On the other hand, the elaboration of the theory of forms and numbers was far from being logically satisfactory: this is shown in the phases of the Aristotelian polemic against the Academy. Again, the mythical construction of the concrete world suggested more fundamental problems than it was capable of solving. Further, Plato not only failed to give direct answers to the difficulties involved in the Pythagorean discoveries and the Eleatic paradoxes, but he also allowed his thought to be coloured by Pythagorean and Democritean influences, in spite of their emphasis on sense experience. Moreover, his disregard for direct observation and experiment may be considered, from the scientific point of view, as an 'unmitigated misfortune'; for many scientists still believe that mathematics becomes "sterilized by losing contact with the world's work." [6]

Under these circumstances, Aristotle had a reasonable excuse for withdrawing his active support from the Academy. Of course, he would agree with Plato that both mathematics and science are the result of deductions from clearly perceived first principles; but he would insist that experience and induction provide many of their elements. Again, he would accept that the method of analytical regression had to be followed by a synthetic progression; but instead of centering this process towards the world of ideas, he would direct it towards concrete reality, and thus stress the parallelism between existence and thought. Finally, Aristotle would argue that the ultimate notions obtained by this double discursive method, need not be mathematical in character, as quantity is only an aspect of being.

Consequently, Aristotle had to reject the Platonic view that there is no necessary distinction between mathematics and science; because he had shown that the study of numbers and figures does not unfold the essence of mind and nature, and does not force its results on both. Just like any other branch of knowledge requiring universals, mathematics involves notions

[6] Hogben, *Science for the Citizen*, p. 64.

which are idealized properties of sensible objects. These notions have not a separate existence, like the Platonic ideas; but they can be isolated by abstraction, so as to provide the matter of mathematical demonstration. For Aristotle, then, mathematics is the development of just one aspect of being, namely the category of quantity; and as such, it loses the all-pervading character it assumed in the Platonic system.

By his reaction against the teaching of his master, Aristotle placed mathematics in its correct station in the universe of knowledge, and opened up new perspectives in mathematical philosophy. Thus, he stressed the rational rigour of mathematics as against its development through dialectical or intuitive speculation. It is true that mathematical invention does not follow any settled succession of particular rules; but it is no less true that the rational value of the results of such invention can be estimated only in terms of their integration in a strictly deductive system.

Moreover, the Aristotelian doctrines of the structural characters of demonstrative science, and of the empirical background of its elements, preserved in Greek mathematics that strong reasonable and factual cast which is found in Euclid in particular and in the mathematicians of the Hellenistic period in general. Though many of these scientists do show traces of Platonic influences, there is no doubt that they used extensively the *Organon,* in their research and in their works. This is so much true, that the so-called sclerosis or static character of Greek mathematics is attributed to the Aristotelian views on mathematics and on demonstrative science.

But even the prevalent static character of Greek mathematics encouraged by the Aristotelian doctrines, should not be considered any more as an outdated conception. Of course, it presents a sharp contrast with the rise of the calculus and modern analysis, which display a dynamic character with their legitimate attempt to rationalize change by describing it arithmetically.

Yet, more recent tendencies in mathematical theory seem to revive, in a certain way, the Aristotelian dualism between number and the logical factors of science, and the subordination of arithmetic to the qualitative requirements of the scientific domain. This is particularly the case with the axiomatic development of projective geometry, the theory of groups, the topological systems, the elaboration of abstract algebras, and the dependence of quantic mathematics on the physical magnitudes of the empirical systems investigated.

In this respect, we may quote Weyl's testimony: "In modern times, Western mathematics has less followed the Greek conceptions than the ideas which came down to us from India through the Arabs: in fact, it has asserted the logical priority of number over geometry. Consequently, mathematicians have investigated the various types of magnitudes with the help of one and the same universal concept of number, elaborated in abstract fashion independently of any eventual application. It may be said, however, that we are now witnessing in mathematics a complete reversal of this perspective. It seems to us that, in the last resort, the more profound view of mathematics is the Greek conception, according to which every domain requires a specific and characteristic system of numbers." [1] The critical analysis of quantum mechanics and of the intuitionist school of mathematics would thus show a direct *filiation* between the ontological and 'naive' realism of Aristotle and the more recent theories or controversies about the nature and value of mathematics.

Turning to Aristotle's influence on the development of natural science, it should be remembered that his distinction between mathematics and physics in a general sense, involves a wider criterion of reality and truth than that required by the Platonic cosmology. This criterion is not reasonableness in thought exclusively, but also consistency in experience. Hence, it would be unfair to suggest that the Aristotelian methodology ham-

[1] *Gruffentheorie und Quantenmechanik* (1928). Pref. p. vi.

pered the progress of the physical sciences. It is true that syllogistic logic as such is of little use for experimental research, where the main object sought is discovery and not formal proof from accepted premises. But Aristotle did not propose the syllogism as the essential method of discovery. On the contrary, as it is well known, his later works especially insisted on the valuable information provided by the use of strict observation and experiment. Surely, he cannot be blamed if his later successors neglected to take his advice. For that matter, it is fortunate that the natural sciences now follow Aristotle's clue on the importance of experimentation, rather than Plato's disregard for direct empirical methods, and his a priori constructions.

It could be said even that the history of science might have taken a different turn, if Aristotle's successors had made a more universal use of his views and methods of experimentation. Surely, it must be their fault if they have neglected them and adopted exculsively his syllogistic and the method of his *Physics* which exhibited more Platonic influences in structure and outlook.

A final remark should be made about the alternative ways proposed by Plato and Aristotle for the unification of knowledge. This unification was made possible by the Socratic conceptualism to which both Platonism and Aristotelianism remained faithful. But Plato proposed to carry it out by extensive arithmetization at the expense of the claims of the concrete world and of the apparent irrationality of change. Equally respectful of the requirements of thought and the empirical characteristics of actual existence, Aristotle sought the elements of the rational unification of knowledge beyond the ontological results of the Platonic dialectic.

These elements, which are essentially formal, are centered round the notion of class, which was already prominent in Plato's rational doctrines, and which gained more emphasis in Aristotle's biological and linguistic considerations. In taking as fundamental the notion of class, as against the idea of rela-

tion which is more prominent in the Platonic system, Aristotle was able to order the objects of knowledge according to an ontological hierarchy of genus and species. This simple notion, however, even though enshrined in an accurate classification of all living organism and in the linguistic expressions of knowledge, did not suffice for the establishment of a science of pure thought: it needed a structural support of a system of relationships carrying necessity with them.

The constitution of a universal organon and of an ontology independent in their own right of any specific mathematical considerations, enabled Aristotle to account for the parallelism of thought and being and to outline the development of our formal and material knowledge without assigning an essential primacy to mathematics. It is true that the Aristotelian logic does not cover explicitly all the problems which are relevant to the science of thought. But it can be shown that it contains the basic intuitions which justify many of the remarkable developments worked out to the present day, by the combined efforts of philosophers, logicians and mathematicians. These basic intuitions properly developed and interpreted, may yield ultimately the means of solving the actual difficulties encountered in logical and mathematical theory and in the application of these formal techniques to our study of nature and of other human interests.

Moreover, by establishing logic as the methodological technique of thought, Aristotle made possible the differentiation of the various sciences: the condition for their development and validation was to be found henceforth in logic alone. Thus, the sceptre of the human intellect passed from mathematics to logic, which kept it unchallanged until the Renaissance, nay, until the present day. With Aristotle, philosophy became simply logical. It is only with Descartes, Leibniz and Newton that we find again comprehensive systems of mathematical philosophy.

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ADLER AND THE EXISTENCE OF GOD

THE RECENT article of Mortimer Adler in the January issue of *The Thomist* prompts immediate attention to the problem of natural theology.[1] Students of natural theology will further be interested by the work of Etienne Gilson in drawing a sharp distinction between Aristotle and St. Thomas.[2] Future work in the field will have to take into consideration the fact that these recent writers have challenged the conception of an Aristotelian-Thomistic natural theology. By doing so they have called for a reexamination of the structure of the natural study of God and the philosophical demonstrations to be contained therein.[3] The recent article by Herbert Schwartz, in the Spring issue of *The Thomist*, refers to the relevant article by Mortimer Adler, but it is thought to be beyond the purpose of this paper to maintain an explicit discussion of the Schwartz article.

While the whole of natural theology must ultimately progress simultaneously, the discussion to follow will be concerned mainly with the existence and negative attributes of God.[4] The discussion will proceed through a consideration of the points raised by Adler. In all events the weighty metaphysics of St. Thomas will be presupposed. No interest will be maintained

[1] Mortimer J. Adler, "The Demonstration of God's Existence," *The Thomist*, January, 1943 (*The Maritain Volume*), pp. 188-218.

[2] Etienne Gilson, *God and Philosophy*, New Haven, 1941. This of course is by no means a full account of Gilson's studies in the matter. However, in his early book on St. Thomas Gilson does not always closely mark a distinction between Aristotle and St. Thomas: *The Philosophy of St. Thomas*, London, 1939 (2nd Eng. ed.), pp. 66-79.

[3] A graphic illustration, gathered from the three most relevant texts, of the structure of St. Thomas' first proof for God can be found in: Jean Paulus, "Le caractère metaphysique des preuves thomistes de l'existence de Dieu," *Archives d'histoire doctrinale du moyen âge*, Paris, 1934.

[4] The most important of the widely scattered texts can be found in: St. Thomas, "Prima Pars," *Summa Theologica* (particularly questions 2-11).

in a natural theology distinct from ontology. Ultimately it will only be possible here to indicate the necessary and adequate philosophical analyses and demonstrations will lie. In conclusion an outline of the steps in a demonstration of the existence of God consonant with the metaphysics of St. Thomas will be presented.[5]

Adler states that the demonstration of the existence of God cannot properly proceed directly from motion, from the causes in our experience, or from the concurrence of God in the agency of these causes. Adler's point is that the demonstration must proceed directly from the contingency in being of the things in our experience, and that the prerequisite of such a demonstration is an understanding with certitude of the contingency in being of these things.[6] It is necessary to understand exactly what Adler is rejecting (and this writer in accord with him), since not a few scholastic writers would seem to uphold the following rejected approaches in natural theology. In regard to a demonstration proceeding directly from motion, the result of such a demonstration could only be at best a first cause of motion whose activity would depend on the previous existence of the things moved, and very likely on a tenuous physical system.[7]

[5] Two texts which can at best only figure partially in this writer's interpretation of St. Thomas are: *Summa Contra Gentiles*, Bk. I, ch. 13; *Compendium Theologiae*, ch. 3. That the *Contra Gentiles* is incompatible on the proofs even with the *Summa Theologica* can perhaps best be seen in the addition of the discussion of the "primum mobile" in the former.

[6] The importance in the proof for God of things contingent in being is perhaps seen most forcibly in St. Thomas' early work, *Scriptum Super Libros Sententiarum Magistri Petri Lombardi*, Lib. I, Dist. III, Divisio Text. "Prima ergo ratio sumitur per viam causalitatis, et formatur sic. Omne quod habet esse ex nihilo, oportet quod sit ab aliquo a quo esse suum fluxerit. Sed omnes creaturae habent esse ex nihilo: quod manifestatur ex earum imperfectione ex potentialite. Ergo oportet quod sint ab aliquo uno primo, et hoc est Deus."

[7] That the physical system of Aristotle is implied in at least the *Contra Gentiles*, where some proofs of the premises relate to local motion alone, can be seen in St. Thomas' commentary on the parallel passage of the *Physics*. "Est autem ad hoc dicendum quod Aristotelis in hoc sexto libro

In regard to a demonstration proceeding from the causes in our experience, the discussion either refers to the causes as dependent in being [8] and as such has no good reason for referring to the things specifically as causes or else it concerns a first in a "series" or "set" of natural agents which would necessitate things existent to be acted upon. The point is that this causality of change or of the preservation of changeable forms is not uniquely referable to God, even if it be described as "principal causality." [9] Nor can the demonstration proceed from the concurrence of God in the activity of natural agents (causes of change), since this is properly a theological deduction, presupposing the existence of God.[10] The agency of things in our

agit de motu secundum quod est continuus. Continuitas autem primo et per se et proprie invenitur in motu locali tantum, qui solum potest esse continuus et regularis. Et ideo demonstrationes in hoc libro positae, pertinent quidem ad motum localem perfecte, ad alios motus non totaliter, sed secundum quod aliquid continuitas et regularitatis participant." St. Thomas, *Commentaria in Octos Libros Physicorum Aristotelis*, Bk. VII, ch. I, lec. I.

[8] Garrigou-Lagrange appears to be unwilling to decide on whether to argue from causes dependent in being or causes dependent in the conveyance of motion. "Ce premier argument prétend etablir l'existence d'une *source du devenir*, en ce sens qu'il est son activité même et n'a pas besoin d'être prému." Reginald Garrigou-Lagrange, O. P., *Dieu: Son Existence et Sa Nature*, Paris, 1914 (2nd ed.), p. 228.

[9] It is evident that for Aristotle (*Physics*, Bk. VIII, ch. 5) the "principal movent" described in traditional argument is not distinctively God. "Either the movent is not itself responsible for the motion, which is to be referred to something else which moves the movent or the movent is itself responsible for the motion. Further, in the latter case either the movent immediately precedes the last thing in the series, or there may be one or more intermediate links: e.g., the stick moves the stone and is moved by the hand, which again is moved by the man: in the man, however, we have reached a movent that is not so in virtue of being moved by something else." In his commentary on this text St. Thomas makes no criticism of it, but further seems to reaffirm it. It would seem that St. Thomas could hardly be taken literally when he uses this same terminology (*Summa Theologica*, I, q. 2, a. 3, and *Compendium Theologiae*, ch. 3) to prove the existence of God. Consider also the addition to this argument (*Contra Gentiles*, ch. 13) which is omitted in the other two texts.

[10] For example, in a relevant passage of the *De Potentia* no attempt is

experience follows from their being, and it is with their being that we must deal. Further, as we shall see later, it is only through our discernment of the contingency of things that we ultimately arrive at knowledge of the negative attributes of God.

Having noted Adler's difficulties regarding the traditional method of proof, we can now examine his proposed alternative method. An outline of his proposed demonstration will precede the discussion of the individual points.

I. There are things contingent in being.
   A. These include composites of substance and accident, composites of matter and form, composites of essence and existence.
      1. In knowledge, we must be able to proceed from composition of substance and accident to composition of matter and form, and then to composition of essence and existence.
      2. The composition of essence and existence alone clinches the contingency of a thing.
   B. There is an essential connection between being a contingent being and not being a *causa essendi* (a cause which brings or holds things *extra nihil*).

II. Through the internal self-evidence of the proposition itself, it is true that a contingent being requires immediately a cause which is itself uncaused.

III. Once we have come to realize that things which are contingent in being actually exist, and that it would be a contradiction to say that such things are possible causes of being, we conclude to the existence of an uncaused being as the direct cause of contingent things.

IV. We know God's attributes from the necessity of denying any composition of essence and existence in God. For in denying this composition, we are also denying certain characteristics which are necessarily consequent upon any of the necessarily

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made to show the necessary dependency of the many causes apart from the presupposed fact of their being creatures. St. Thomas, *De Potentia*, q. 3, a. 7.

inter-connected compositions: essence and existence, matter and form, substance and accident.

A further consideration here suggests itself regarding the importance of a knowledge of the contingency of things in the beginning of any demonstration of the existence of God.[11] If in seeking the ultimate *raison d'être* of the world of things we are unable to know that these things are caused in being, it is difficult to see how we could know with certitude that some particular fact or event in the world, such as motion, could not in some way be traceable to these beings. In seeking the marks of contingency in being we are doing fundamentally what St. Thomas has done in ascertaining the negative attributes of God. Certainly we cannot know the attributes of God by way of pure logical deduction. Granting this, we must say that the knowledge implied in the treatise of St. Thomas on the attributes of God has its true foundation in the implications of the character of the opposites to the divine attributes in the beings which come under our experience. This is one way of saying that in the proof of God's existence, in the rise from creatures to Creator or Conserver, must be contained the whole of natural theology. To discern the marks of createdness is the real problem and heaviest labor of natural theology.

This brings us to ask what is meant by the composition of essence and existence. (The views presented here may perhaps distinguish the opinion of this writer from that of Adler.) An answer to this question cannot be obtained, as Adler agrees, through the casual jockeying of logical principles. Nor, on the other hand, is it directly known through the facts of change.[12]

[11] There appears a kind of confirmation of this view in John of St. Thomas, *Cursus Theologicus*, Disp. 3, "De Deo an sit," a. 2. It is difficult to appreciate Cajetan's commentary particularly on the first proof. Since God can be neither "anima caeli" nor "anima mundi," what good can a proof be that suggests God is one or the other? Cardinal Cajetan, *Commentaria in Summam Theologicam*, I, q. 2, a. 3.

[12] It would seem that this could be presumed until a valid demonstration be referred to on the contrary.

The expression " composition of essence and existence " is used to describe the cohabitation or combination within a being of a principle of limitation and a principle of perfection, in the order of being.[13] The fact of this composition is known only through tedious metaphysical analysis and inference, beginning with the beings in our experience. The fundamental point of departure in our knowledge of this composition lies in the fact that a multiplicity of beings exist: i. e., a multiplicity of *things*, not merely a multiplicity of forms or accidents of a particular kind.[14] The study might also set out from the aspect of the limitation in being of these things. This study is *par excellence* one of ontology and not of cosmology. A being which is in reality a composite of essence and existence is not immediately known as a contingent being, but is knowable as contingent through the implications of this composition. It is regrettable that an adequate demonstration of these points cannot be made here; however, we may go on to see what they imply.[15]

Anything which is not composite of essence and existence could be said to be unlimited in its being and unique in its being. Since it would be unlimited and unique in the order of being, all possibility of limitation or multiplicity in any order is denied to it. This follows because composition in the order of being (essence and existence) is the ultimate intrinsic *raison d'être* of composition of whatever order. If a thing is unlimited

[13] Fernand Van Steenberghen, " La composition constitutive de l'être fini," *Revue Neoscholastique De Philosophie*, Louvain, 1938, pp. 489-518. Toward the end of this aritcle the author makes an historical study to allay the misunderstanding that has identified " essence " and " existence " respectively with " res " and " ens."

[14] *Ibid.*

[15] *Ibid.* The following is an indication of the line of reasoning to be found in Van Steenberghen's demonstration. A simple being could not be the subject of two contradictory attributes, each of which expresses it completely. The finite being, as being, is the subject of two contradictory attributes. (It is completely reality. It is completely opposed to reality, the reality of every other being.) Therefore, the finite being, as being, is non-simple or composed.

in the order of being, there is no conceivable perfection to which it might change, since every such perfection is itself in the order of being. Since composition of essence and existence is in the order of being it must be said to be the ultimate intrinsic factor in the determination of the character of the being in which it is the total constitutive. Thus, we say that identity of essence and existence in God (apart from a formal exclusion of other compositions) is by itself sufficient to establish in our knowledge the unicity, infinity, and immutability of God. It is difficult in view of the above to agree with Adler's point that we must proceed in knowledge from one composition to another in order to know the composition of essence and existence. His point would seem to be based on what appears to be an erroneous belief that corruptibility is the only adequate sign for us of composition of essence and existence, or even that corruptibility is an immediate sign of this. It may well be that no body can be both moved locally and incorruptible, but this does not mean that either composition of substance and accident or composition of essence and existence implies necessarily the composition of matter and form.

Similar to the line of thought which would lead us to consider the composite of essence and existence as contingent in being (the composite's implication of dependency) is that which suggests the contingency in being of the other types of composites. St. Thomas himself seems to hold that the composition either of substance and accident or of matter and form would of itself be sufficient to indicate the contingency in being of a thing.[16] The kind of substance here spoken of is of the substance which requires accidents for its existence, and there is no intention of denying that the being which is composite of matter and form or of substance and accident may be reducible to a composite of essence and existence.

[16] *Summa Theologica*, I, q. 3, a. 2 and a. 6.

A being which *is* in such a way as not to be identical with its determinations and specifications (a composite in the order of essence, and hence a composite either of substance and accident or of matter and form) somehow receives these determinations or specifications, which are necessary for its being, from outside. In other words, matter and substance cannot exist apart from form and accident. Ultimately, however, form and accident could not be given to matter and substance by agents who had power to cause change, without necessary reference to agents that have power to cause being. This is so because every conveyance of form and accident by such an agent implies a previously existent changeable thing to be acted upon, a thing already possessing form and accident. Thus every composite of these types must have received specifications and determinations prior to all change at the hands of agents who were limited *ex hypothesi* to the causality of change. Since the matter and substance could not exist without these specifications the composite must have come into being as the specifications came into being, outside of all change and presupposing no previous existent thing out of which it was to be made. Thus, in order to have been and to be, the thing composite of matter and form or of substance and accident requires to be produced and maintained *extra nihil* simply.

The above outline of a demonstration in metaphysics is hardly complete but will indicate lines that might be followed in demonstrating the contingency in being of a composite of substance and accident, or a composite of matter and form. Such a demonstration may ultimately challenge the Thomistic doctrine of the philosophically possible eternity of a world of composites of substance and accident or of matter and form. The demonstration might be based on the fact of local motion alone, along the following lines. Things moving locally require at all times, in order to be, a disposition " in place " relative to other things moving locally—some particular disposition. No *particular*

disposition or "place" can be completely *a se* to the thing, since the thing is clearly compatable, from the fact of its movement, with many dispositions or relative "places." The dispositions cannot be explained ultimately by agents limited to causing merely change, since these always require a previous existent thing to be acted upon, a thing already "in place." Thus that which is locally movable must ultimately receive from some agent that which is required for its being and consequently its whole being prior to its existence in the world of change at all.

We come to the consideration of the progress of the demonstration from contingent being to non-contingent being. Once again we must seek a deeper understanding of the real beings in our experience. The point of departure of our whole demonstration lies in the search for their ultimate *raison d'être.* It was this which caused us to go beyond our initial knowledge and to look within their being in order to discern ultimate intrinsic principles of being. When these principles can be known to imply the contingency of a being, we go further in our search. We shall be apt to accept a less than adequate explanation of a thing, unless we appreciate fully both the being of the thing, and the radical contingency of its being. We are here dealing with being as beings. Our discussion is not in cosmology, it is in ontology, and in natural theology insofar as natural theology can be said to partake of ontology.

Thus, the radically contingent thing is so constituted that the entirety of its being is dependent. It is *extra nihil,* and yet within itself there is no explanation of its being *extra nihil.* Here is a dependency that is far deeper and more significant than the dependency of the changed thing on that which changes it. And, the fact of being *extra nihil* is a far more important fact than the fact of receiving this determination rather than that. The fact of the existent thing which in no way explains its existence is our point of departure.

We seek a cause of the radically contingent thing. We want to solve the problem of this dependency, not to add to it. An adequate and sufficient cause is required. A cause with completely satisfactory interiority, with an ultimate character to its causality, is needed to solve the problem. What we are looking for is an adequate and genuine explanation, not a partial explanation or a postponement of the question.

Here it is necessary to distinguish between an immediate cause and an ultimate cause. An immediate cause in this case would be such that it would be directly required from the nature of the causality involved. An ultimate cause is such that a completely satisfactory explanation of the effect involves it, apart from the question of whether intermediary causes be involved. Thus, the immediate cause refers to the nature of the causality, the ultimate cause to the unexplained existence of the effect.

Adler suggests that for the purpose of the demonstration we must seek the immediate cause of the being known as contingent. We do not question the possibility of a proof for God as the only immediate cause of being, or its efficacy in supporting the demonstration of God's existence. The only question is whether it is absolutely required for this demonstration. The existence of a cause that is both necessary and adequate seems demonstrable without reference to whether this cause is immediate or not.

What then can be said of this cause which has been called adequate or ultimate? We can partially answer this by seeing whether the contingent being in our experience can ultimately explain the being of another thing. We know that the causality or operational capacity belonging to a thing is only rationally distinct from the being of the thing. The character of a being is necessarily reflected in its exercise of activity. The thing contingent in being is therefore also contingent in causality. (Here we refer to the causal contingent being as dependent in

its causality through its dependency in being, not to the contingent cause considered as " motus movens " by Aristotle or as the stick used by the man in hitting the ball.) We say that the contingent being cannot be an ultimately satisfactory cause of anything, since it itself is dependent. Here the question of whether a contingent being could be a mediate or non-ultimate cause of being is prescinded from in the direct line of the discussion. The entirety of the contingent being is dependent. Thus, it can be a final or completely satisfactory explanation of nothing at all.

Since a contingent being offers us nothing toward the ultimate explanation of things, the existence of a non-contingent being is necessarily demanded by the existence of contingent things. The existence of the uncaused cause of being is known directly through the exigencies within things for an adequate explanation beyond them, an explanation and not a postponement of or an addition to the needs of the explanation. Thus, we have not so much a proof as an explicitation of the requirements and capacities of contingent being.

In the discussion no set or series of contingent beings acting as intermediaries in the causality of being is postulated. Here is not a *reductio ad absurdam.* The *reductio ad absurdam* may well be used in dialectic against those who would maintain the possibility of an ultimate cause in a set of " causae essendi," but the positive knowledge of contingent being can give us more directly what ultimately must be implied in the *reductio.* Here is no question of the causality of change and the peculiar problems relevant to it. With the above in mind we can see that there is no concern here for argument, however valid, against an infinite set of causes. Nor, are we concerned with a first in a series or set of causes. Our concern is with an ultimate and satisfactory cause of being, not with the number or possibility or existence of contingent intermediaries.

The suggestion (which Adler proposes as difficult to refute)

that there might be a circular series of "causae essendi," such that A, the first member, causes the being of N, the last member, through the instrumentality of the intervening members, and N in its turn causes the being of A, is seen to be impossible when we realize that on this hypothesis A would be a *causa sui.* True it would be so *mediately,* i. e., through N (and the members of the series before N); but even a mediate *causa sui* is impossible. For the dynamic (or causal) aspect of a thing's being is only rationally distinct from that being of which it is an aspect. Apart from the question whether every fully constituted being is thereby a cause, there can be no doubt that to be a cause in the order of being, an entity must be already fully constituted in being. This is the positive reason why a thing cannot be a *causa sui.* Thus, a thing cannot cause its own existence since it would have to exist already to do so.

Precisely the same line of reasoning applies to the question of reciprocal causality involved in a circle of causes. Each thing is a *causa sui* and would be in virtue of its own causality. Again the positive point is that the causality of the thing presupposes the being and thus cannot be the cause of the being in any sense, apart from the question of whether there are or could be intermediaries. It is difficult to see how this point can be ignored, unless one supposes that the operation of a thing can be ontologically explained, and can function, apart from the being of which it is the operation.

In presenting the following outline of a valid proof for the existence of God, it is regrettable that a full metaphysical demonstration of the points involved cannot accompany it. The outline is not a literal interpretation of St. Thomas but it is the opinion of this writer that its points are fundamentally in accord with St. Thomas' various treatises on natural theology.

I. Beings exist which are known to be metaphysically composite in any one of the following compositions: substance and accident, matter and form, essence and existence.

A. These beings include composites of matter and form and composites of substance and accident (whether one composition is known to be found with the other or not).

1. Both composites can be known, on the basis of implied multiplicity and limitation in being, to be composites of essence and existence.
2. Both can be considered according to their own specific composition and as such have a special relation to the order of being.

B. These include composites of essence and existence which are known to be such either through being multiple in being or through being limited in being.

II. Every being which is metaphysically composite can be shown through metaphysical analysis not to have within itself the sufficient reason of its own being.[17]

A. This includes composites of essence and existence.

B. This includes composites of matter and form (considered apart from their relation to the composition of essence and existence).

C. This includes composites of substance and accident (considered apart from their relation to the composition of essence and existence).

III. A thing caused in being by another cannot be adequately and satisfactorily explained except by something uncaused in being.

A. Being requires completely satisfactory explanation, absolute in the sense that it leaves nothing beyond to be explained.

B. The *ratio* of contingent being prevents it from being adequate or satisfactory, since whatever it is or does it is or does in virtue of something else.

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[17] The incompleteness at this point of the traditional argument against a simultaneity of potency and act (even were it just a question of motion) can be seen in St. Thomas, *In Physicorum*, Bk. 8, ch. 5, lec. 10. The further difficulty involved in making this point in the line of motion rather than in the line of being is evident in Scotus and Suarez. Joannis Duns Scotus, *Commentaria Oxoniensia*, Lib. II, Dist. II, Quaest. X; Francis Suarez, *Disputationes Metaphysicae*, Disp. XXIX, Sec. I, no. 7. Also the avoidance of the question by John of St. Thoms is of interest. John of St. Thomas, "Philosophia Naturalis," *Cursus Philosophicus Thomisticus*, I. P., q. XXII, art. I.

IV. There is necessarily a being which is explanatory of composites, a conserver of their being, and which is itself simple and uncaused.

A. This being must be unchangeable (not composite of matter and form or substance and accident).

1. This is so since each of these compositions necessarily implies composition of essence and existence.
2. This is so since each of these compositions, apart from relation to essence and existence, implies contingency in being.

B. This being must be unique, since whatever is, or can be, multiple in being is composed of essence and existence.

C. This being must be infinite, since whatever is limited in being is composed of essence and existence.

At the conclusion of this study of Adler's article it is impossible to refrain from a statement of frank admiration for his purpose, his method, and his work. Adler has sought to be clear, even to the point of evolving a method of philosophical writing, and has not been satisfied to copy and to speak of the "lucidities" of thirteenth century formulas. More important than this, he has not taken up the "party spirit" and traditional "front" which have made useless many of the studies in the field. It would seem that future successful work in natural theology will also have to consider the problems presented by the language and presentation of St. Thomas, and particularly the precise character of the "Aristotelianism" in his works.[18]

WILLIAM BRYAR.

[18] Two excellent studies on the first proof of St. Thomas which indicate at least where the trouble lies in more or less literal interpretations are: André Bremond, S. J., "Le Dilemme Aristotelicien," *Archives de Philosophie*, Paris, 1935; Marcel Chossat, S. J., "Dieu (Son Existence)," *Dictionaire de Theologie Catholique*, Paris, 1911.

IMMEDIATE INFERENCES: ARE THEY REALLY INFERENCES?

ON PAGE 198 of his "Petite Logique" M. Maritain asks the question, "Y a-t-il des inférences immédiates?" It is an interesting question and one that may repay study. I shall essay a study of it here.

That there may be no confusion I shall immediately define my terms. By *immediate inference* I mean a process by which from a single given proposition, we derive another, the truth of which is implied by the former. (I do not here include the inferences to be drawn from the Square of Opposition.) Most authors are agreed as to what is included under this name, and I shall list here the forms which are recognized by three modern authors, who enumerate them rather fully.

Joseph [1]	*Stebbing* [2]
Conversion	Conversion
Obversion	Obversion
Conversion by Negation	Contraposition
Contraposition	Inversion
Inference by Added Determinants	Obverted Contrapositive
Inference by Complex Conception	Obverted Inverse

Joyce [3]

Conversion
Obversion
Obverted Converse
Contraposition
Obverted Contrapositive
Inversion
Obverted Inverse
Inference by Added Determinants

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[1] *An Introduction to Logic*[2], p. 232 sqq.
[2] *A Modern Introduction to Logic*[2], p. 63 sqq.

Inference by Omitted Determinants
Inference by Complex Conception
Inference by Converse Relation
Inference by Modal Consequence

The matter under discussion being now sufficiently defined and limited, the all-important question arises, "Are these processes really inferences?" Inference I define, in its most general sense, as a passage from a known truth to one as yet unknown. Obviously then, to ask this question is equivalent to asking this other, "Are these processes anything more than a mere explicitation of an implicit contest, i. e., do they constitute a real progression to a new and unknown truth?" If this be answered affirmatively, then it must be granted that these processes are really and truly inferences; but if it be answered negatively, it follows that they do not deserve to be so called. I answer it negatively, and shall now set forth my reasons for so doing.

First of all, it will be advantageous to divide all the so-called inferences into two groups; those which are formal in character, and those which are material. By "formal inferences" is here meant those which owe their supposed illative-validity to the transformations to which the logical form of the original proposition is subjected. The "material inferences" on the contrary, owe all their force to the significant content of the proposition rather than to its logical form.

To proceed to the first of these: the inferences of the formal type which are all obtained by the process of transposing subject and predicate, or by changing the quantity or quality of a proposition, or by some combination of these (under this heading fall Conversion, Obversion, Conversion by Negation, Contraposition, Obverted Contraposition, Obverted Converse, Inversion, and Obverted Invert), would seem to be nothing more than mere explicitations of what was implicit in the original

[3] *Principles of Logic*[2], p. 93 sqq.

proposition. In other words, to obtain these new propositions nothing is necessary other than the consideration of the original proposition from a new and different angle; from which new point of view that which was implicit in the original proposition becomes explicitly evident to the mind. As Father Joyce says, "The conclusion of an immediate inference declares some fact already formally asserted in the premiss. If we have understood the premiss, we already know the conclusion."[4] Mr. Joseph in like manner thinks that "there is no inference where there is no movement of thought; . . . it must involve an advance to the apprehension of a fresh object of thought, and be more than a mere playing as it were upon the same object . . . there is no advance" when the movement is "to the thought of something not thought of, though bound up with what was thought of at the outset."[5] There is undoubtedly a movement of the mind from one proposition to another, but not exactly from one truth to another. For it would seem that all these varying propositions merely express varying aspects of the one same truth. As M. Maritain, in speaking of two propositions, one of which was immediately inferred from the other, says, "ces deux propositions ne font que signifier *purement et simplement la même vérité*, l'esprit *n'avance point* en passant de l'une a l'autre, il y a là simplement deux manières différentes de dire la même chose, de construire le même objet d'assentiment."[6] But movement such as this, from aspect to aspect of the same truth is not inference, which is essentially movement to a new and unknown truth.

It may be objected in defense of the truly illative character of such movements of the mind, that in the syllogism also inference is nothing more than a making explicit of that which was implicit in the premisses; and this is unquestionably true: were it otherwise the conclusion would be unwarranted by the

[4] *Op. cit.*, p. 92.
[5] *Op. cit.*, pp. 240-1.
[6] *Op. cit.*, p. 198.

premisses. But the point precisely is that immediate inference differs from syllogistic inference by reason of that which is implicit in each case. In immediate inference all that is implicit is the sum of the varying relations which can hold between the subject and predicate of the same proposition; in syllogistic inference, on the other hand, what is implicitly contained is the subsumption of a term in one proposition by a term in another, for as soon as the intellect grasps the minor " qua " minor, i. e., as subsumed by the major through the medium of the middle term, the conclusion necessarily follows: and this conclusion is not merely a different aspect of one original proposition, it is a new truth drawn from the conjunction of two others. The objection, then, is invalid since the explicitation in immediate inference is different from that in syllogistic.

For a more detailed study of the formal types of immediate inference, Conversion and Obversion must be considered in particular, for they are the two fundamental and simple forms. Conversion is applicable to three types of propositions, A, E, and I; i. e., SaP becomes PiS, SeP becomes PeS, and Sip becomes PiS. Let us start with the conversion of A proposition:

All metaphysicians are profound thinkers SaP

converts to: Some profound thinkers are metaphysicians PiS

This second proposition is obviously different from the first proposition, but is the truth enunciated therein different from the truth enunciated in the original one? I think not. Rather, it would seem to be the same truth looked at under a different aspect, and in consequence the second proposition seems to be merely a further explicitation of the original proposition. But since inference must needs be an advance to a new truth, and not to a different aspect of the same truth, there cannot be an inference here. Judging the two remaining types by the same criterion, it seems that they too must be denied the name of inference. For instance, an E proposition:

No warriors of Marathon were Medizers SeP

converts to: No Medizers were warriors of Marathon PeS

and an I proposition:

Some characteristics of Mycenean craftsmanship are Homeric SiP

converts to: Some characteristics of Homeric craftsmanship are Mycenean PiS

In both these cases, new propositions have resulted, but no new truths have been ascertained, for the converses are obviously mere explicitations of the relations latent in the convertends.

The same judgment must be passed on Obversions as can be seen readily enough from a consideration of specific instances; first, an A proposition:

All Greeks were lovers of beauty SaP;

obverts to: No Greeks were non-lovers of beauty $Se\bar{P}$;

second, an E proposition:

No Thomists are Molinists SeP

obverts to: All Thomists are non-Molinists $Sa\bar{P}$;

next, an I proposition:

Some mathematicians are philosophers SiP

obverts to: Some mathematicians are not non-philosophers $So\bar{P}$;

last, an O proposition:

Some educators are not philosophers SoP

obverts to: Some educators are non-philosophers $Si\bar{P}$

Here again, if I mistake not, the same critique may be advanced against the presence of inference properly so-called. The mind indeed passes from the original proposition to a new

one, but not from the original truth to a new one. The truth enunciated in the second proposition in each of these groups is the truth of the first proposition looked at from a different point of view.

Since all the remaining formal types, i. e., Conversion by Negation, Contraposition, Abverted Contrapositive, Obverted Converse, Inversion, and Obverted Inverse, are obtained by various combinations of Conversions and Obversion, it follows that they too have no rightful claim to the name of inference.

Before proceeding to the material types, however, it will be necessary to consider the opinion of Mr. Joseph [7] that in some of the cases treated above there is real inference. He argues thus, "'No X is Y' converts simply to 'No Y is x.' The convertend implies commonly the existence of instances of X, but not necessarily of Y. Now if in the convertend it be meant that there are instances of both X and Y, the thought that the latter are not the former hardly seems separable from the thought that the former are not the latter; . . . If however this be not meant in the convertend, and in the converse it be meant that there are instances of Y, then there is inference, but it involves another premiss." It most certainly does! It requires a premiss affirming that instances of the predicate of the convertend exist. Hence this is not immediate inference and in this discussion does not seem to be quite "ad rem."

He then continues, "I might judge that 'nothing inductive is self-evident,' while doubtful whether anything is self-evident; If I proceed to judge that 'nothing self-evident is inductive' meaning that there are self-evident propositions, the judgment that these are not inductive comes by the help of the convertend, but that they exist at all is independent of it. Still, I cannot reach the universal 'nothing self-evident is inductive' without realizing that if anything were self-evident, it would not be inductive; and this connexion of condition and consequent is

[7] *Op. cit.*, p. 244 sqq.

not the same as what is realized in the universal negative from which I started; that was, that if anything were inductive, it would not be self-evident. From 'if X, then not Y' to 'if Y, then not X' does seem to be inference, the condition being different in the two." Leaving aside the question (which was just treated above as to the existential import of the propositions, there still remains to be examined the conclusion that there is real inference, because of the fact that the hypothetical statement of the converse is different from the hypothetical statement of the convertend. It seems to me that he has gone astray here, for the conditional statements seem to express the same truth, no matter which term is put in the antecedent or which term in the consequent. I shall attempt to make this evident by using the symbols of the mathematical logicians. Using the same example as Mr. Joseph, I shall signify "induction" by p, and "self-evident" by q. Substitute these values in the following equivalencies,

$$(p \supset \sim q) \equiv \sim (p \cdot q) \equiv \sim p \vee \sim q$$
$$(q \supset \sim p) \equiv \sim (q \cdot p) \equiv \sim q \vee \sim p$$

and it is obvious that the two conditional statements enunciate the same truth, viz., "induction" and "self-evident" cannot both be true of the same thing, either one or the other must be false.

Consequently, I think Mr. Joseph has erred on this point; which for all practical purposes he admits a little further on, "Only then if an E proposition be intended as a statement that the two groups of instances exclude each other . . . is its conversion not inference." But that is exactly what occurs in an E proposition, for both the terms in such a proposition are distributed.

He further thinks that there is real inference in obversion when the predicate term which has been negatived is in reality not purely negative. In other words, instead of non-Y meaning

simply "something else than Y," it may mean some definite alternative Z. In this case he says, to have valid inference, we require further a disjunctive premiss stating that X is either Y or Z. By this very fact, however, all chance of considering it immediate inference is destroyed, for the second premiss demolishes its immediate character.

It would seem then that his opinions as to the presence of real immediate inferences were unfounded, and consequently they do not necessitate a revision of the opinions which I have set forth above.

Now that it has been established that the formal types are not real inferences, the material types must be examined to see whether or not the same is true of them.

Upon due examination it will be found, I think, that in these cases too the apparently illative process is in reality nothing more than an explicitation of something that was implicit in the original proposition. To substantiate this opinion it will be advantageous to consider two of the more important types of material inferences, viz., Inference by Converse Relation, and Inference by Added Determinants.

In the Converse Relation type the proposition *Aristotle was the son of Nicomachus* gives as its inferred proposition *Nicomachus was the father of Aristotle*; in other words, "the terms are transposed, and the relative name which was attributed to the previous subject, is consequently replaced by the correlative, which is attributed to the new subject." [8] Now this, it would seem, is a most evident case of mere explicitation of implicit ramifications of the same truth, for the use of correlative terms is a crystal-clear case of the technique of obtaining different formulations of the same truth by the simple device of looking at it now from one point of view, and now from another. From which it follows that Converse Relation is not inference *stricte dicta.*

[8] Joyce, *op. cit.*, p. 103.

As regards Inference by Added Determinants, there is no advance here either from a known truth to an unknown. Take, for instance, the statement *A Doric temple is a beautiful work of art*; by an added determinant this becomes *A Doric temple in ruins is a beautiful work of art in ruins.* But surely the second proposition is implicit in the original one, and this new form wherein subject and predicate are qualified is nothing more than a specification, a particularization, an explicitation of the original proposition, and not an inference derived therefrom. And what is true of these two types is also true of the remaining material types.

This examination of Immediate Inferences has shown, I think, that neither the formal nor the material type has made good any claim to the name of inference. Neither in the one case nor in the other is there a real advance from a known truth to a new and, as yet, unknown one, and since it is precisely this advance which is the essential note of a real inference, any process in which it is lacking cannot possibly be inference.

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NOTICES AND COMMENTS

NOTICE TO MEMBERS OF THE AMERICAN CATHOLIC PHILOSOPHICAL ASSOCIATION

Last April the Secretary received a very urgent letter from the Office of Defense Transportation asking that our Association join the patriotic organizations which have cancelled their annual meetings this year in view of the present unprecedented military demands upon the country's transportation system. The Secretary forwarded the letter to President Leo Ward, who in turn sent copies to the Executive Council members asking a vote on the question of holding our proposed meeting in Milwaukee on December 29th and 30th, 1944. The Council voted eight to two not to have the meeting and hence this is an official notice to the members of the cancellation of the 1944 meeting.

The dropping of our national meeting is all the more reason for increase of activity of local round tables in Philosophy under Association auspices. Very successful gatherings of this kind have been in progress in New York, Philadelphia, Boston and Washington in addition to our regional meetings in New Orleans, San Francisco and Portland. At our meeting in Philadelphia in December, 1941, a Committee on Local Round Tables was appointed with a large sub-committee having representatives from most of the larger cities. This sub-committee still stands and is now headed by Dr. Joaquin Garcia, C. M. of St. John's University, Brooklyn, N. Y. as chairman, with Dr. Joseph B. McAllister of Catholic University, Dr. Francis Meehan of St. John's Seminary, Brighton, Mass. and Dr. Charles McFadden of Villanova College, Villanova, Pa. as the other members of the Committee. Members are urged to get Round Tables started in their respective cities as a substitute for the annual meeting and as a means of acquainting their communities with the work of the Association. More than ever ideas are ammunition in war and in peace as well. Chairmen of the various Round Tables are requested to emphasize the fact that the meetings are being held under Association auspices and to invite those attending to membership in the Association. A local organization should be effected for the regular holding of discussion meetings at stated intervals. The experience of the general committee members can be obtained as all of them have conducted most successful meetings in their respective cities.

At our last meeting the Association voted to invite members of the Association to express their views on "The Role of Philosophy in the College Curriculum" with a view to formulation of an official Association statement on the subject. Members should send their observations to Rev. Stephen McNamee, S. J., Georgetown University, Washington, D. C., chairman of the Committee. Any official statement must await action of the next general meeting of the Association.

CHARLES A. HART,
Association Secretary.

By order of LEO R. WARD,
Association President.

THOMISTIC BIBLIOGRAPHY

A new analytical bibliography of thomistic literature is in process of publication. Heretofore the only complete work has been the *Bibliographie Thomiste* of Mandonnet-Destrez, ending with the year 1920.

Dr. Vernon J. Bourke, learning that no supplement to the *Bibliographie* was planned by the original publishers and assured of their wish to see the work undertaken, has compiled a list of over 4,000 titles covering the years 1920-1940. There are four indices, and the book is so arranged according to categories that it will serve as a supplement to Mandonnet. Dr. Bourke has added a critical introduction on the chronology and authenticity of the works of St. Thomas, with some useful information about the various editions of these works.

The book is being printed as a supplement to volume XXI of *The Modern Schoolman,* and will run some two hundred and eighty-eight pages. Prices will be: for the paper-bound edition, $2.00; for the cloth-bound edition, $2.50.

BOOK REVIEWS

The Problem of Divine Anger in Arnobius and Lactantius, by ERMIN F. MICKA, Catholic Univ. of America Studies in Christian Antiquity, edd. J. QUASTEN, No. 4. Washington, D. C., 1943. Catholic Univ. of America Press, XXII. a. 187 pp.

The problem discussed in this book is of interest not only to speculative and to natural theology, but also to philosophy in general because it entails the difficult question of affectus, i. e. of quasi-emotional movements, in a rational and spiritual substance. Anger is listed among the *passiones animae* and, accordingly, linked up with the *appetitus sensitivi* and the bodily organization in man. But God is repeatedly said to be angry in the Scriptures; the *anima separata* is said to love God; so are the angels. These are indubitably important problems. Any contribution towards a better understanding, therefore, must be welcomed.— The author studies the notion of Divine Anger in two writers of the early Christian times when all these problems were, so to speak, only gradually discovered and also only gradually clarified. The first part summarizes the *status quaestionis* before 300 A. D., by reviewing the Scriptural passages, referring to the denial of divine anger in the Stoic and Epicurean philosophies, and studying the synthesis of the opposed Scriptural and philosophical ideas in the heresy of Marcion and the latter's influence on early orthodox and hetrodox writers. It seems to this reviewer as if the Stoics were dealt with a little too summarily; the author agrees with Hicks in saying that the whole of Stoic philosophy was complete at the beginning of the third century B. C.; but there were important additions made by Panaitios and Poseidonios the ideas of whom ought to be considered because of their influence on the Latin Stoics (Cicero, Seneca) on one hand, and on Neo-Platonism on the other. Nor does it seem correct to claim, without further qualification at least, that the Stoics did not recognize any distinction but one of the mind between matter and the Deity. The notion of a World-Soul, which Seneca eventually identifies with the Godhead, deserves to be noticed. The second part deals with the ideas of Arnobius which center around what the author terms the 'aloofness of God.' Arnobius holds that anger and divine nature are fundamentally incompatible with one another. Arnobius apparently had rather con-

fused notions and his knowledge in theology was more or less poor. Lactantius whose teachings are discussed in the next part had a deeper conception of the problem. His interest focusses not so much on the description and definition of the passions as in the influence they exercise on man for good and evil. He rejects the Stoic doctrine that the passions are as such evil and to be uprooted; only their abuse must be avoided. Moderation, preconized by the Peripatetics, has to refer not to the passions as such, but to their objects. Regarding anger, Lactantius teaches that it is 'a motion of the soul rousing itself to curb sin.' Just anger, therefore, is not a prerogative of God alone. He relates anger to justice. The last part compares the teachings of the two authors. A useful and detailed index is added.

RUDOLF ALLERS.

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Traditio, Studies in Ancient and Medieval History, Thought and Religion, edd. J. QUASTEN and ST. KUTTNER, Cosmopolitan Science & Art Service Co., New York, 1943, Vol. I., iv and 418 pp.

The growing interest in studies like those contained in this volume has rendered the available space for publication more and more insufficient. The war has limited this space even more. The editors, therefore, have justly felt that a series of volumes of which this is the first would be welcome and useful. If one surveys the content of the present volume one cannot but agree with this sentiment.—According to the wide scope indicated by the subtitle, not all the articles are of immediate interest to the philosopher, although as contributions to the History of Ideas they deserve his attention. Of these articles we list only the titles: *Vivum saxum, vivi lapides*, the concept of 'living stone' in Classical and Christian Antiquity by J. C. Plumpe; *Oriental Influence in the Gallican Liturgy*, by J. Quasten; *Missa Graecorum, Missa St. Johannis Crisostomi*, by A. Strittmatter; *Medieval Georgian Historical Literature*, by Prince G. Toumanoff; *Bernardus Compostellanus Antiquus* (a glossator of Canon Law), by St. Kuttner; *Jordanus of Saxony's Vita St. Augustini*, the source for John Capgrave's Life of St. Augustine, by R. Arbesmann; *Plena potestas and Consent in Medieval Assemblies*, by G. Post; *Observance of the Purification* in the East in the Seventh Century, by M. J. Higgins. The following articles are definitely of philosophical interest:

Th.-André Audet contributes an article '*Orientations théologiques chez Saint Irénée; Le contexte mental d'une γνῶσις ἀληθίς*,' which he informs us is part of a larger study on the idea of evolution in St. Ireneus. The question is to determine in what sense Ireneus speaks of a 'true gnosis' as set over against the false gnostic systems he criticizes. The procedure of the author is not historical or philological; he does not want to find parallels between Ireneus and his predecessors; he rather uses a psychological method, trying to penetrate into the very spirit of his author and to understand his intention on the basis of a constructive picture of his whole mentality. Three factors can be, as it seems, distinguished. Ireneus' original faith, he being—a rare thing with the authors of these times—born and raised in the faith; his realism and empiricism, and his interest in the salvation of his flock. The latter consideration forced him to adopt a more practical and simple way of exposition and controversy and suggested to him a certain distrust of mere reasoning in opposition to the intellectual pride of the heretical gnostics.

A. Landgraf continues his studies on the philosophy and theology of the twelfth century in two essays (in German), the first dealing with *Nominalism in theological works of the twelfth century*, the second with the *Literary History of the Sentences of Robertus Pullus*. Several testimonies, the most important by Petrus Cantor, reveal the existence of nominalism after 1150. Landgraf wants to determine what kind of doctrine was considered nominalistic in these years. There are reports on this point in Aquinas, Bonaventure, Peter of Capua, William of Auxerre, and several others. The criterion of nominalism seems to be, for the writers of the twelfth and early thirteenth centuries, the adoption of the proposition *quod quidquid semel est verum semper est verum*. This implies the equivalence of propositions in whatever a tense they be couched. Thus, he does, he did, he will do, are identical propositions. This has a direct reference to theologoumena, insofar as the position in this regard decides on certain aspects of Omnipotence, of Creation, Redemption, etc. It is interesting, how much of these ideas were incorporated by the Lombard in his Sentences. The many glosses taken from unedited codices reported by Landgraf are exceedingly illuminating. The main point of contention is the 'nominalistic' claim that *Deus quidquid potuit potest*. Another aspect of the question is of a moral nature, concerning the identity of sin in will and act. In spite of the frequency of nominalistic utterances, it is not possible to speak of a solid nominalistic school among the theologians of the twelfth century.

It must be noted that the author is concerned here only with the theological schools, and not with the 'dialectitians' s. str. Abelard, accordingly, is mentioned only incidentally. Nor is there a reference to the well-known passage in which John of Salisbury claims that there were no longer any representatives of nominalism, i. e. followers of Roscellinus, at his times.—The second essay deals with the relations between Robertus Pullus on one hand, Peter the Lombard, Abelard, Gilbertus Porretanus on the other.

Ph. Boehner reports on *The notitia intuitiva of Non-Existents according to William Ockham*, with a critical study of the text of Ockham's *Reportatio* and a revised edition of *Rep.* II., q. 14-15. The distinction between a *notitia abstractiva* and a *notitia intuitiva* was common with the Scholastics of the fourteenth century. Ockham became acquainted with it through Scotus who in turn had taken over the idea of Henry of Ghent. The latter, following St. Augustine, had taught an immediate contact with reality and, therefore, denied the necessity of a *species* intelligibilis, whereas Scotus had retained this concept. Ockham returned to the original position of Henry. He wanted to 'base knowledge on the safe ground of reality in intuitive knowledge, and to eliminate any element, as for instance a species, that could becloud the immediate vision of reality'; such an idea would, Ockham feared, lead to skepticism because it prevented an immediate contact of the mind with things. Curiously enough, it was this very idea which brought down on Ockham the reproach of skepticism. The reason for this mistake is an erroneous interpretation of Ockham's philosophy on the part of his critics. Intuitive knowledge is of contingent facts; it is that from which experience starts; it is concerned with existence. Abstractive knowledge is of 'the elements of a non-existential proposition'; it is either of a universal, *abstrahibile a multis*, or it abstracts from existence and non-existence, presence or non-presence, inherence or non-inherence of contingent facts. Since intuitive knowledge is only of the actually present, it cannot afford a basis for statements on the past; Ockham speaks of a *notitia recordativa s. intuitiva imperfecta.* There is, however, also another causation of a *notitia intuitiva* besides the presence of the object, namely it can be produced in the senses and the intellect by God and thus be *de re non existente.* God's knowledge of every contingent fact, past, present, or future, is intuitive, and therefore also of non-existents. Man lacks naturally such a knowledge because he depends on the intuition of contingent facts; in principle, however, intuitive knowledge is possible, i. e. it may be granted to man by

God's grace. Intuitive knowledge, whether natural of an existent object, or supernatural of a non-existent object, is essentially infallible; it admits of no error, which would be a 'clear contradiction.' Intuitive knowledge implies factual evidence. (It is not without interest that, in regard to sense-evidence similar ideas, obviously in independence of the *venerabilis inceptor*, have been proposed by some contemporary psychologists and philosophers; K. Jaspers' notion of 'self-giveness of an object' is of this kind. These questions have a definite bearing on the theory of illusion and hallucination, generally speaking of perceptual error.) The author reviews some criticisms, medieval and modern, brought forth against Ockham's theory. In the second part of his article he studies the manuscript tradition and gives a critical edition of the pertinent questions.

The three articles reviewed here at some length, although of course in a rather fragmentary manner, are as everyone will see, important contributions to the history of philosophy and deserve the fullest attention of every student of its problems. The philosopher gladly welcomes this new periodical as a valuable source of information. We may look forward with eager interest to the publication of the volumes to follow.

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BOOKS AND PERIODICALS RECEIVED

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Auerbach, Leo. *The Babylonian Talmud.* New York: Philosophical Library. Pp. 286.

D'Arcy, M. C. *Thomas Aquinas.* Westminster, Md.: Newman Bookshop, 1944. Pp. ix + 292.

Davila, J. *Critica.* Mexico: Buena Prensa, 1941. Pp. xvi + 394.

Del Campo, R. Martinez. *Theologia Naturalis.* Mexico: Buena Prensa, 1943. Pp. xxvii +430.

Donohue, James J. *The Theory of Literary Kinds: Ancient Classifications of Literature.* Dubuque, Iowa: The Loras College Press, 1943. Pp. vii + 155.

Glenn, Paul J. *An Introduction to Philosophy.* St. Louis: B. Herder Book Co., 1944. Pp. viii + 408.

Hamm, Victor M. *Pico Della Mirandola of Being and Unity.* Marquette University Press, 1943. Pp. 43.

Jordan, Pascal. *Physics of the Twentieth Century.* New York: Philosophical Library, 1944. Pp. xii + 185.

Kerins, James F. *The Social Role of Self Control.* Washington, D. C.: Catholic University of America Press, 1943. Pp. xi + 167.

Meyer, Hans. *The Philosophy of St. Thomas Aquinas.* St. Louis: B. Herder Co., 1944. Pp. viii + 581.

Meyer, Wendelin, and others. Translated by Andrew Green. *The Pastoral Care of Souls.* St. Louis, Mo.: B. Herder Book Co., 1944. Pp. iv + 353.

Maritain, Jacques. *Christianity and Democracy.* New York: Charles Scribner's Sons, 1944. Pp. 98.

Moran, J. G. *Cosmologia.* Mexico: Buena Prensa, 1944. Pp. xiv + 389.

Parente, Pascal P. *The Ascetical Life.* St. Louis, Mo.: B. Herder Book Co., 1944. Pp. xiii + 271.

Tillyard, E. M. W. *The Elizabethan World Picture.* New York: The Macmillan Co., 1944. Pp. 108.

PERIODICALS RECEIVED

Anglical Theological Review. Vol. XXVI, No. 3, July, 1944.

Bulletin of The John Rylands Library, Manchester. Vol. 28, No. 1, March, 1944.

Estudos. Maio-Junho, No. 3, Ano III, 1943.

Fordham Law Review. Vol. XIII, No. 1, March, 1944.

Philosophy and Phenomenological Research. Vol. IV, No. 3, March, 1944; No. 4, June, 1944.

Resurgimiento. Ano III, No. 1, Enero-Abril, 1944.

Revue de l'Universite d'Ottawa. Vol. 14, No. 2, Avril-Juin, 1944; No. 3, Juillet-Septembre, 1944.
Speculum. Vol. XIX, No. 2, April, 1944.
The American Journal of Economics and Sociology. Vol. 3, No. 3, April, 1944.
The Harvard Theological Review. Vol. XXXVII, No. 2, April, 1944.
The Jurist. Vol. IV, No. 3, July, 1944.
The Philosophical Review. Vol. LIII, 3; May, 1944; No. 4, July, 1944.
The Review of Religion. Vol. VIII, No. 4, May, 1944.
Studies (Irish Quarterly Review). Vol. XXXIII, No. 130, June, 1944.